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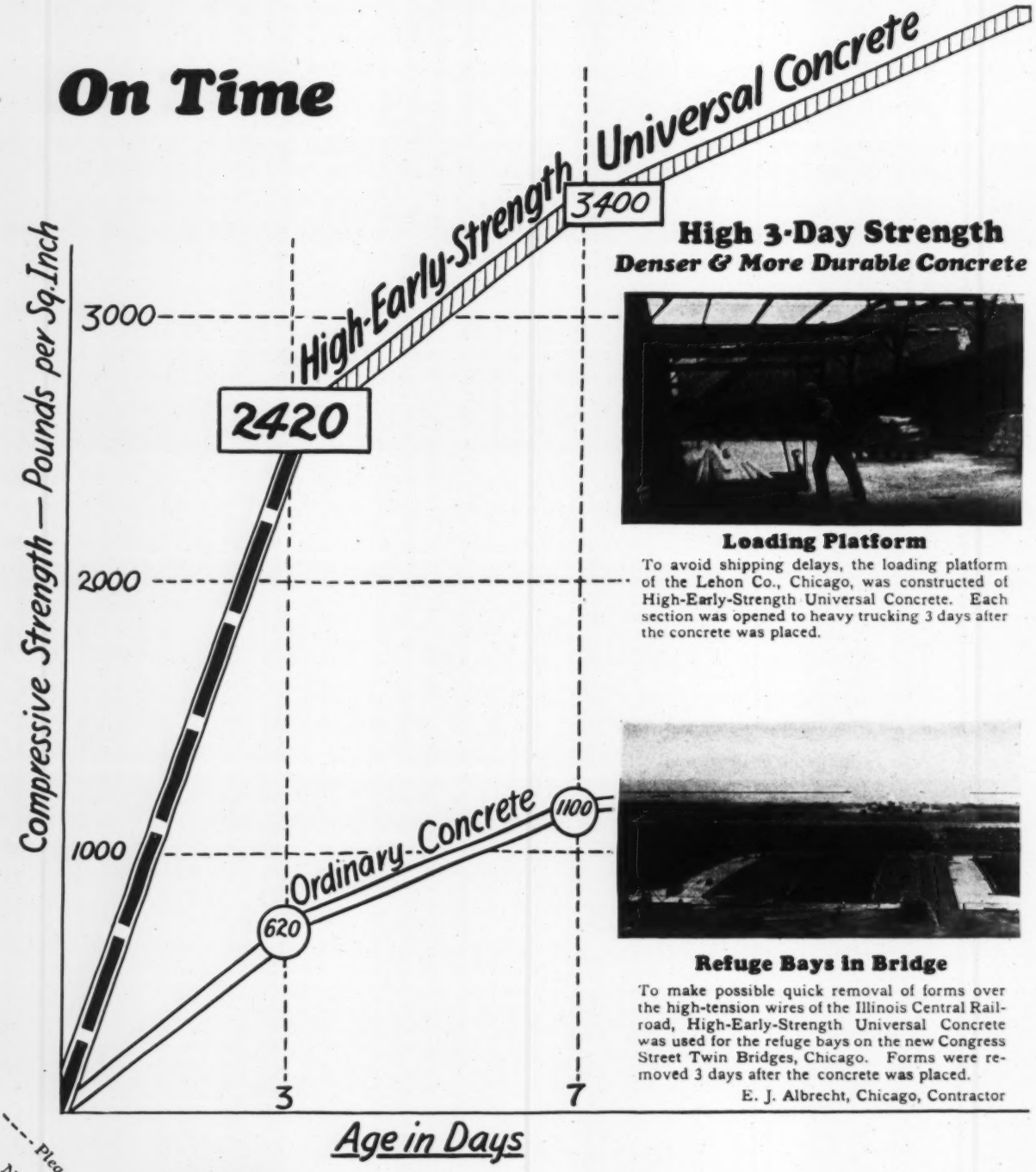

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Railroad Issue

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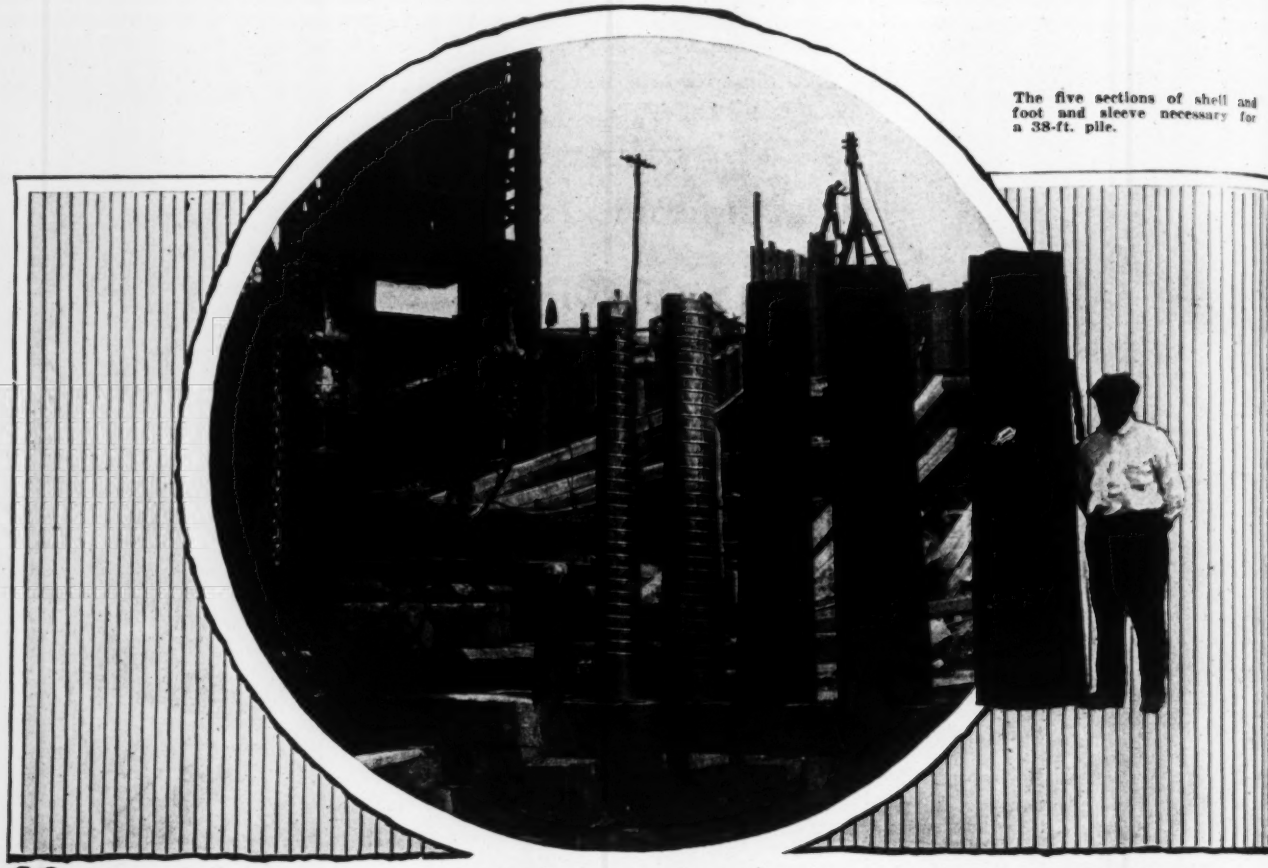

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Volume 102 NEW YORK, FEBRUARY 28, 1929 Number 9

This Issue

FEW fields of activity include as wide as a variety of engineering problems as does that of railroad construction and operation; few have as wide a general interest. An engineer who would be conversant with railroad construction and maintenance must be familiar with everything from the latest method of earth and rock excavation, through bridge and building construction and track design to the most approved means of softening water for locomotive consumption. Individual developments are recorded from time to time without indicating the extent to which the entire field is progressing. Consequently it seems desirable on occasions to devote the greater part of an issue to outstanding examples of the work which railroad engineers are doing and to some of their problems. That has been done in this issue. Typical examples of the diversity of construction problems are given in articles on the Cascade tunnel and the reconstruction of North Station at Boston, and an example of the railway maintenance engineer's problem is given in the summary of the present status of substitute ties. All are of more than usual interest.

A Significant Anniversary

THE American Railway Engineering Association when it assembles in Chicago on March 5 will have completed 30 years of service to the profession. Begun in a small way three decades ago for "the advancement of knowledge pertaining to the scientific and economic location, construction, operation and maintenance of railways," the association has developed and expanded its activities with the growing need for a scientific approach to the railroad engineer's problems. Seventeen men attended the meeting held on Oct. 21, 1898, at which the organization of such an association was discussed, and about 125 attended the first regular meeting in Buffalo on March 30, 1899. This year the attendance will be in the neighborhood of 1,400. Only a few subjects were considered by the first committees to be appointed; today 26 large and active committees, which are broken down into many subcommittees, are studying a multiplicity of subjects—many of which, like automatic train control, were unthought of when the association was organized. The work of these committees is centered upon developing the association's manual of recommended practice, and in carrying out their studies they have compiled a vast amount of data of inestimable value to railroad engineers. The A.R.E.A. is unique in this respect; no other engineering society devotes so much time to the collection and compilation of data of such direct interest to its members. It would be a mistake, however, to give the impression that its activities have been limited to an interpretation of what has been done in the past, for some of its committees have done valuable research work, notably its committee on stresses in railroad track. In this the association is living up to its possibilities; pushing out ahead into those fields where research is needed, it has made itself the foremost engineering organization in the railway field throughout the whole world.

Page Hercules

THERE is need for a superman to cleanse the Augean stables at Chicago. Not alone must the sanitation plan maintained for three decades be radically reshaped to conform to the Supreme Court dictum that lake water shall not be used for flushing the city's sewage into the Mississippi; not alone must the independent actions of the city administration on water supply and the Sanitary District on sewage disposal be co-ordinated; but the greater task must be performed of rehabilitating two organizations which are bankrupt morally as well as financially. The Sanitary District has frittered away every shred of public confidence by financial mismanagement and patronage jobbing. It has no money to meet its current payrolls, let alone operate its sewage-disposal plants. Yet now it is called upon to raise funds amounting to scores of millions of dollars, in order to speed up and intensify in degree of treatment the sewage-disposal program of the district. To get the needed money it must induce the public in referendum vote to authorize the necessary bond issues, which in its present condition of destroyed confidence the public is in no way inclined to do. Nor is the state legislature any more likely to help out the district. The city administration is in little better condition, yet the district's case is the really critical one. A board of engineers is now at work devising a more complete sewage-disposal plan than the one under construction and projected, but engineering is really the minor problem of the situation. The board's big opportunity is to devise a method and point out the strong man who will restore public confidence, raise the funds and build the works rapidly and efficiently.

Pavement Use and Width

IN HORSE-AND-BUGGY days a pavement 14 ft. wide was ample to provide clearance. Most cities have a remnant—and a large remnant it usually is—of pavement whose width was determined by this criterion. The sight recently of two loads of hay passing recalled the heated arguments not so long ago for widening the 14-ft. country road slab to 16 ft. The 8-ft. wide bus and truck then came along and pushed up pavement width to 18 and 20 ft. Now new studies are essential to provide for present-day vehicles and modern speeds. As a starting point the width of pavement zone which the motorist actually is using is significant information. In studies made in the Cleveland regional survey it is found that without marked lanes pavements less than 40 ft. wide down to 20 ft. wide serve only as wide two-lane streets. No use is made of the 3-ft. zone on each edge of the pavement on a 32-ft. surface. Evidently if pavement

width should conform to pavement use and if the available width were to be used efficiently, a proper alignment of traffic into lanes is required.

Good Financing

THE tenth annual convention of the Associated General Contractors held last week in Chicago was notable because it recorded the knotting up into definite purpose of some of the loose threads of activity which have been spun in building a chaotic business into an association with unified objective. There still remains much to be done if the association is to approach with a positive program the many problems which confront contracting. Chiefly there has to be brought about a system of financing which will make the association certain of the amount of its income and which will assure collection of dues without resorting to the debtor's courts. Today too much of the time of paid experts employed to solve contracting problems is taken up in waiting for assurance that the money with which to carry on their work will be available, and indeed in acting as door-to-door collectors. There are many and vital problems ahead of associated contracting; they cannot be met by officers who have to devote large fractions of their time to kitchen financing and nursery bickering. There may be justifiable difference of opinion as to methods—indeed, the battle over bylaws in the executive session of the convention demonstrated this fact—but there should not be two opinions about the need of change from present conditions. This work cannot be attacked too soon or too earnestly.

Meetings and Exhibits

EVENTS are rapidly driving home the teaching that meetings and exhibits do not belong together. The lesson was emphasized a month ago by the American Road Builders' Association convention, and again last week by the meeting of the Associated General Contractors. Business sessions and discussions carried on in annex rooms of a noisy exhibition hall do not function to best effect. So flagrant a case of bad meeting arrangement as that at Chicago brings this truth out convincingly. That the contractors managed to get through their program and actually accomplish something is creditable; but they accomplished it only against a formidable handicap of noise and confusion, increased by the puffing of a gas engine just outside the meeting door. In an atmosphere more compatible with deliberation and decision they might have done much more effective work. The contractors' organization is progressing steadily toward high-pressure activity in its meetings, and on this account has need for efficient meeting arrangements. Important problems have to be solved and many differences of view harmonized, all in good temper and thoughtfully. These things cannot be done amid the distractions of an exhibit.

Efficient Procedure

IN VIEW of the just-mentioned conditions at Chicago it is fair to assume that the close interest manifested at the convention of the Highway Officials of the North Atlantic States, held at Atlantic City two weeks ago, was in part due to quiet and to orderly procedure. With a registration of nearly 2,000, the convention brought together in each session a large fraction of this total; few left or entered during a session, and active interest continued throughout. Undoubtedly the meeting accomplished distinctly larger results than would have resulted under less efficient procedure. However, to do the organization full justice, certain other elements need to be mentioned as contributing to its effectiveness. The membership being regional instead of national, the convention place is in easy reach of all, and the work and problems of roadbuilding throughout the region are strikingly similar. Accordingly an unusually close bond of technical fellowship exists among the members. The program, moreover, was strong and well balanced, which was a factor in developing interesting discussions of the papers. And finally, the manufacturers' exhibits were not near the meeting hall. Altogether, the convention had more than one point worth the study of society managers.

Single-Hump Freight Yards

MATERIAL enlargement of the field for the gravity switching system in freight yards is indicated by the successful use of a single hump to serve train movements in both directions. For yards with heavy concentration of traffic the logical arrangement is to provide two switching humps, as has been done in numerous cases. But each hump, with its track-scale and other equipment, is a costly investment and involves continual expense in operation and maintenance, so that the double-hump arrangement is economical only for the larger class of yards. If the cost of construction, equipment, operation and maintenance can be reduced by the intensive use of a single hump to serve all switching movements, then the gravity system, with its economies and other advantages, will be practicable for smaller yards with lighter total traffic.

A conspicuous example of this single-hump system of operation is in the new yard of the Texas & Pacific Railway at Fort Worth, Tex., as described in *Engineering News-Record* of Jan. 10, 1929, p. 63. Here the two classification yards are adjacent and parallel, served by a hump at one end. For eastbound traffic there is the normal continuous or direct movement into the receiving yard and over the hump into the classification yard. Cars in westbound movements are run beyond the hump and then move eastward over the hump into the classification yard, from which the trains again start westward. Local conditions minimize the usual objections to reverse movements in yards, and these objections are offset by the advantages and economies of the single-hump arrangement.

That a single hump may be satisfactory even if it handles traffic in only one direction is illustrated by several yards now in operation. One of the first was that of the Chicago, Burlington & Quincy Railroad at Lincoln, Neb. This yard was designed originally for a duplicate layout and two humps, but in consequence of a business depression only one hump was built. Eastbound movements were passed over the hump and switched by gravity, while flat switching was employed for westbound movements. At Lincoln this combination was adopted as a matter of necessity, due to unexpected conditions, but in several recent cases it has been adopted purposely. Thus, in the newly reconstructed yards of the Norfolk & Western Railway at Portsmouth, Ohio, and Williamson, W. Va., there is a single hump for gravity switching of the heavy westbound coal traffic. In eastbound movements, the classification and assembling of cars is done by flat switching, assisted by light grades on the ladder tracks.

With the possibilities of gravity switching by means of single humps and with the economies resulting from the use of car retarders in place of hand control of the cars when moving by gravity, there seems likely to be an increase in the use of gravity switching for yards of moderate size and business.

The Substitute Tie

IT IS fairly well known that substitutes for wood ties in railway track have been the subject of numerous designs and somewhat extensive experiments during the past 30 or 40 years. The present situation in regard to such substitutes is reviewed elsewhere in this issue because of the basic importance of the tie to railway operation. As the review shows, no real progress has been made and no definite result or knowledge attained, in spite of service trials.

Today, the substitute tie is still in its earlier stages of development. There is no tie available that can meet the treated or even untreated wood tie in open competition as a commercial product. Nor is there any definite knowledge of what the life or economic cost will be. For instance, a certain small lot of ties lasted in track for several years, but a second and larger lot of the same design failed and had to be removed in less than one year. Again, before there is time to determine the efficiency or merit of certain ties placed in the track for experiment, the inventor brings out a new or modified design which is characterized as an improvement.

What is the reason for such an inconclusive situation? Probably the main reason is that the problem has not been handled on an engineering basis. It has been left mainly to inventors and promoters. Small lots of ties, sometimes crudely made, are permitted to be laid, often to receive little careful observation as to performance. Some railroads do not even possess drawings showing the construction of substitute ties which are in their tracks. True, there are a few cases where such ties have been used in large numbers, but these either give results no more conclusive than the others or are too recent to permit of any conclusions. True, also, that substitute ties are in extensive use in other countries, but these are used under conditions differing from those of American railways and their success simply indicates that substitute ties may be practicable under certain conditions.

Consider, on the other hand, the development of the treated wood tie, which is now established on a sound commercial and economic basis. A decreasing supply of timber suitable for ties, with relatively short life and rising cost, seemed at one time to threaten an acute tie shortage. But the introduction of effective preservative treatment changed the situation entirely. It not only increased materially the life of woods ordinarily used but it also greatly increased the source of supply by permitting the successful use of many species which otherwise would be worthless for the purpose.

How was this thoroughly successful result accomplished? Engineers, chemists, biologists and others studied for years the structure of wood, the causes and processes of decay, the properties of preservatives, the methods of treatment, the effects on various kinds of wood and the economic aspect in determining material and method of treatment to give the best results at reasonable cost. All this has been supplemented by study of the protection of treated wood from mechanical wear, and by close observation of the behavior or service of different kinds of treated ties under various conditions of climate and traffic. Railways have used them extensively and have kept careful record of their service. As a result, there is a wealth of definite and reliable information by which to determine the value of given kinds of treated wood ties under specific conditions.

If similar systematic thoroughness of investigation and trial had been given to the subject of substitute ties for an equal period of time, there might now be available some definite information on such fundamental points as: (1) satisfactory designs; (2) methods of manufacture; (3) grade or composition of steel to stand shop work and resist corrosion and cracking; (4) suitable composition of concrete to stand up under track service without spalling, disintegration or fracture; (5) practicable or permissible weight; (6) reliable forms of rail fastenings, and (7) effective insulation against track-circuit current in the rail. Such data would supply knowledge of the practical and economic aspects of the steel tie and the concrete tie that today is not available.

But here the question arises whether the substitute tie is so practical or economic an issue as to demand study on such a broad scope. When the decreasing supply of wood for ties threatened a shortage, there was urgent need for study of conservation of the supply. Substitute ties were too few, unknown and costly to be a factor. How the situation was met and remedied has been noted above. Whether there may be eventually a shortage even in woods suitable for treatment is a matter of the rather remote future. But if a substitute tie can be produced that will compete in price, efficiency and economy with the treated wood tie, its introduction need not wait upon a shortage in the supply of timber, for it must be remembered that protection of wood against both decay and wear adds to the price of the tie and probably to the unit of annual cost.

Can substitute ties provide a better track construction or track structure than is provided by wood ties? Nothing definite can yet be said on this point. Reliability, general efficiency, life, first cost, maintenance cost, salvage and annual unit cost all enter into this case. Tie renewals not only are costly but usually cause disturbance of track structure that results in bad riding conditions until additional maintenance cost has been expended in surfacing and lining. Reduction in renewals, therefore, is important in many ways. Certain stretches of track laid with substitute ties are said to require less maintenance than adjoining track on wood ties, but the experience is far too limited to admit of any conclusion.

It is essential to consider the tie as one unit in the track structure, of which rails, fastenings and splices are also integral parts, with ballast and roadbed closely related as the support or foundation. Weak or inefficient splices or rail fastenings may be detrimental to otherwise good track, and with substitute ties the fastenings have often proved unsatisfactory. This aspect of track design becomes of particular importance on account of the great increase in weights and wheel loads of locomotives and cars, in weight and speed of trains and in density of traffic on main-line tracks.

That there is a field for the substitute tie is evident. But, to summarize, as yet there is no substitute tie which can compete effectively or commercially with the treated wood tie on American railways, nor is much knowledge available as to design, service or economy of substitute ties. Yet, in spite of the severe combination of requirements to be met and in spite of the negative or discouraging results of past trials it seems that the problem should not be beyond solution.

Driving the Second Cascade Tunnel

Methods and Records in Driving Cascade Tunnel for Great Northern Railway's Third and Lowest Crossing of the Rocky Mountains—Relocation on East Approach Line

AS THE longest railway tunnel on the American continent, the fifth longest railway tunnel in the world and because it was driven at a high rate of speed with record-breaking progress, the new 7.8-mile Cascade tunnel of the Great Northern Railway, in Washington, is an engineering work of exceptional importance and interest. A view looking from the eastern portal is given in Fig. 1. Begun in December, 1925, the tunnel was completed in December, 1928, and was opened for traffic on Jan. 12, 1929. It gives the railway an easier and shorter crossing of the Cascade Range of the Rocky Mountains, with a lower summit elevation, and eliminates a circuitous stretch of line subject to heavy snowfall and having numerous snowsheds. A comparison of the old and the new lines is given in Fig. 2 and Table I, while Table II compares the Cascade tunnel with some other long railway tunnels.

The original crossing of the range by the Great Northern Railway was an open-air switchback line, opened in 1892, having grades of 3½ and 4 per cent, and with its summit at El. 4,059 in the Stevens Pass, discovered in 1899 by John F. Stevens, chief engineer for the railway. This open summit was abandoned in December, 1900, with the completion of the first Cascade tunnel, 2¾ miles long, with a summit at El. 3,382 and having maximum grades of 2.2 per cent, while the tunnel was on a grade of 1.69 per cent. With increasing traffic, a still more favorable line at a lower elevation became desirable, and after 1915 several routes were surveyed, giving tunnels 6 to 16 miles in length, but the project was shelved on account of the World War. In 1921 it was taken up again and after extended surveys and investigations the present route was adopted in 1925, with a tunnel 7.8 miles long, on tangent and having a continuous grade of 1.56 per cent descending toward the west. Besides giving better operating conditions, it provides permanent protection against the dangers of snowslides and eliminates the heavy cost of maintenance and renewal on about 6 miles of snowsheds, as well as the operating costs for snow removal on the open track.

TABLE I—CASCADE TUNNEL LINES; GREAT NORTHERN RAILWAY

	Old Line	New Line	Advantage of New Line
Length of line, miles	17.65	9.99	7.66
Length of tunnel, miles	2.7	7.8	.....
Curvature, total, deg.	2,147	190	1,957
Curvature, max. deg.	10	6	.....
Curvature; total feet of max.	7,600	937	6,627
Grade in tunnel	1.69	1.56	.....
Grade, max., per cent	2.20	2.20	.....
Grade, miles of, max.	14.1	0.77	13.33
Summit elevation, ft.	3,383	2,882	501
Total rise, westward, ft.	546	45	501
Total fall, westward, ft.	1,325	824	501
Snowsheds, miles	6.04	0	6.04
Tunnels, miles	3.66	7.8	.....
Bridges, miles	0.23	0.04	0.19

In the construction scheme, both a shaft and a pioneer tunnel were driven to enable work on the main tunnel to be attacked from numerous headings. At about 2.4 miles from the east portal, Berne, a valley provided a convenient location for an intermediate shaft. With this completed, a drift was made 66 ft. to the south and a pioneer tunnel was then started westward. At the same time headings for the main tunnel were driven west from the portal and both east and west from the shaft. At the west end, Scenic, both the pioneer tunnel and the main tunnel headings were started eastward. The pioneer tunnel served as a haulage way and furnished means for carrying air and water lines and taking care of drainage. It was not considered necessary to have a pioneer tunnel on the shorter stretch east of the shaft.

TABLE II—LONG TUNNELS

Tunnel	Location	Length, Miles	Single or Double Track	Date of Construction or Completion
Simplon, No. 1	Europe	12.45	Single	1895–1906
Simplon, No. 2*	Europe	12.45	Single	1921
St. Gothard	Europe	9.28	Double	1878–1892
Loetschberg	Europe	9.03	Double	1906–1913
Mont Cenis	Europe	7.98	Double	1871
Cascade	U.S.A.	7.79	Single	1925–1929
Moffat	U.S.A.	6.11	Single	1923–1928
Rogers Pass	Canada	5.02	Double	1913–1915
Hoosac	U.S.A.	4.38	Single	1854–1876

*A pioneer tunnel in connection with the first Simplon tunnel was enlarged later to form a second single-track tunnel.

A tunnel 11¼ miles long in Italy is being driven for the new direct line line between Florence and Bologna. Work is in progress from both ends and two shafts. The railway, to be completed in 1931, will be 60 miles long, as against 82 miles by the present line, and will have high-speed electric equipment.

Planning and Performance—As the contract called for completion of the tunnel in three years, it was necessary to plan for rapid progress in order to guard against contingencies. A vitally important factor in the successful outcome was the advance planning and scheduling of the several stages of the work and then following the

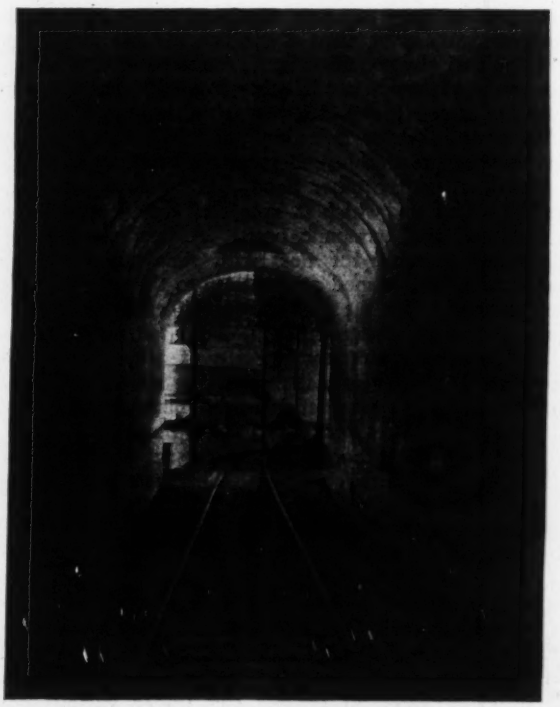


FIG. 1—IN THE CASCADE TUNNEL

schedule closely in the actual construction. This chart is shown in Fig. 4.

Organization of the forces was another important matter, and this included changes of shifts at the face, one drilling crew replacing another without stoppage of the drills. Labor-saving machinery was used extensively. Work was carried on in three shifts daily, including Sundays and all holidays, even July 4 and Christmas. Rivalry existed among the crews, and a bonus system was introduced to encourage rapid work, as described in *Engineering News-Record* of Nov. 25, 1926, p. 858. As a result of all these measures, progress records in tunneling were broken, as noted later. At one time there were nearly 1,800 men on the work.

Difficulties there were in plenty. While the rock was generally solid and hard granite, there were stretches of bad ground and shattered seamy rock containing water under pressure. These treacherous conditions necessitated slow and careful work and prompt placing of heavy timbering. Inflow of water reached a maximum of about 10,000 g.p.m. and required large pumping capacity to prevent flooding of the headings. However, there was no such long stretch of "squeezing" ground as was encountered by the Moffat tunnel in Colorado, requiring heavy steel lining and causing at least one disastrous slide as well as slowing up the work for several months. Nor did the water flood the headings so as to stop work, a condition which also delayed work on the Moffat tunnel.

Rock Temperature—From preliminary studies a curve of rock temperatures on the tunnel line was drawn, beginning with 60 deg. F. at the portals and rising to a maximum of 100 deg. at the deepest point. Actually it began at about 55 deg. and reached a maximum of 70 deg. Typical conditions are indicated by Table III.

Summary of Progress—The contract was let Nov. 26, 1925. The 2.4-mile section of the main tunnel was started at the east portal Dec. 29, 1925, and was driven 9,533 ft. in 431 days, meeting the 3,200 ft. driven from the shaft on March 4, 1927. The shaft had been commenced Feb. 8, 1926, and completed on July 15.

At the west end, work on the pioneer tunnel was started Dec. 14, 1925, at its portal. In January, 1926, an inclined adit was started on the east side of the Tye River 2,270 ft. east of the portal, so as not to have operations delayed by possible troubles in driving under the river. The pioneer tunnel from the portal was connected to the adit in September, 1926. From the Mill Creek shaft the pioneer was started in October,

TABLE III—ROCK TEMPERATURES

Distance From West Portal, Ft.	Depth From Surface, Ft.	Temperatures Outside Air, Deg.	Heading Air, Deg.	Heading Rock, Deg.
2,400	200	52	53	52
10,500	2,230	40	80	68
11,970	3,250	64	74	70
17,646	2,435	52	70	65

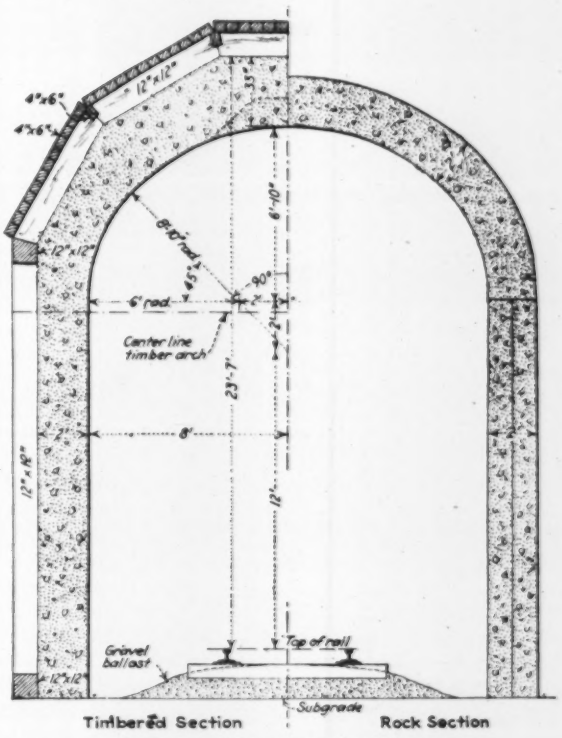


FIG. 3—TYPICAL CROSS-SECTIONS

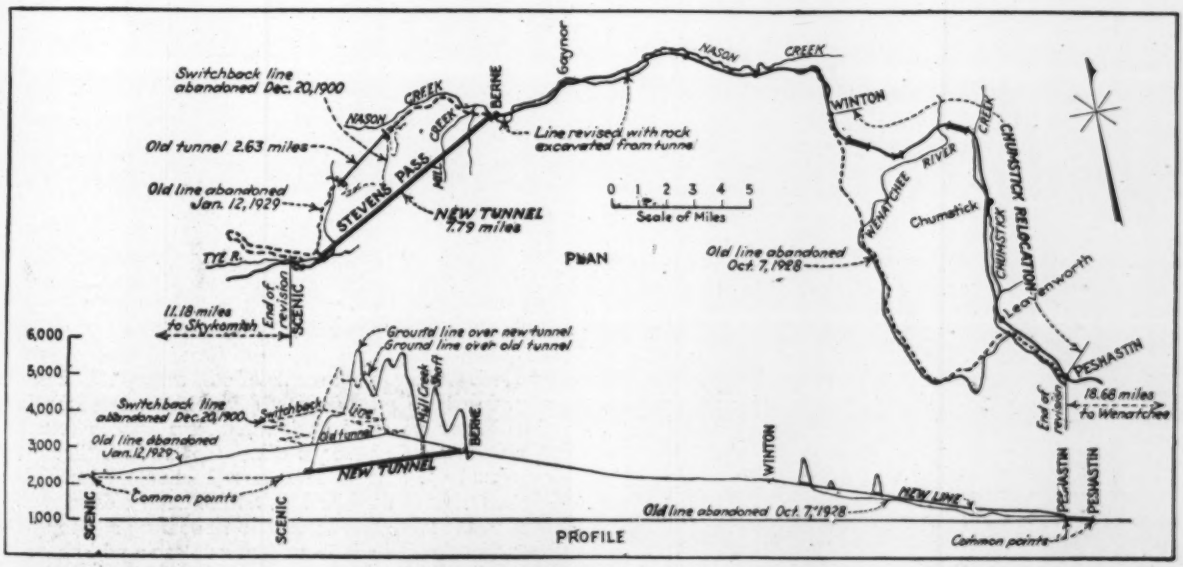


FIG. 2—COMPARATIVE PLAN AND PROFILE

Shows original open-air switchback line through Stevens Pass; the first tunnel line and the second tunnel line opened Jan. 12, 1929

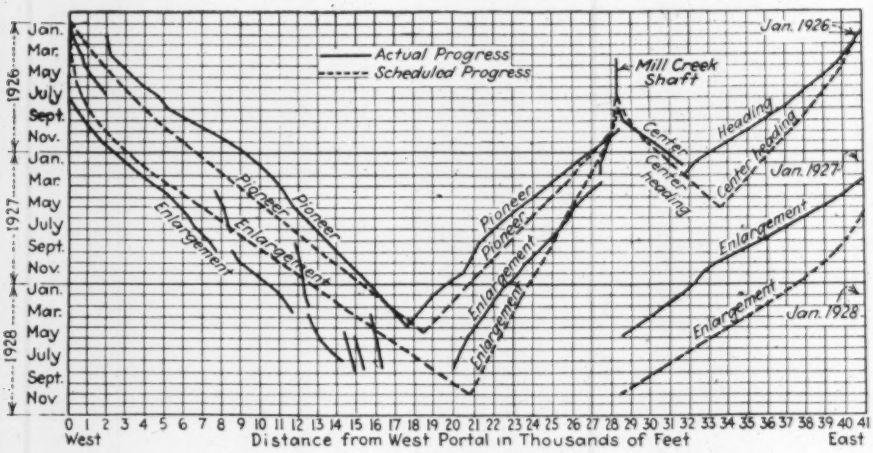


FIG. 4—DIAGRAM OF PROGRESS SCHEDULE

1926, and in April, 1928, it had advanced 10,535 ft., while the advance from the west portal was 15,460 ft., the headings being holed through on May 1, 1928, when the final shot was fired by President Coolidge, who closed the electric circuit by pressing a button in his office in Washington. This pioneer tunnel was 28,292 ft. long, with 94,900 cu.yd. of excavation. The main headings between the shaft and the west portal met Oct. 20, 1928, by which time 6½ miles had been lined with concrete and another mile enlarged ready for the concrete.

Enlargement to full size, with an approximate rock section 18x25 ft., was started at the east portal in March, 1928, and completed to the shaft in May, while enlargement between the shaft and the west portal was completed Dec. 8, 1928. The total length of this tunnel is 41,152 ft., with 839,700 cu.yd. of excavation. It is lined with concrete to a finished section 16 ft. wide and 20 ft. 10 in. high. Lining began at the east end Oct. 12, 1926, and was completed Dec. 24, 1928. Its average thickness is 33 in., requiring 262,564 cu.yd. of concrete and giving a finished section 16 ft. wide and 20 ft. 10 in. high above head of rail. Tracklaying began Dec. 25 and ballasting Dec. 29, the track being completed on Jan. 6, 1929. Some of the speed records are noted in Table IV.

Surveys—In the location work, the first survey was a 10-mile traverse connecting the portals and used for the first drifting at each end. For a closer determination of the length of tunnel a precise traverse was made, with four lines 13,800 ft., 25,100 ft., 7,700 ft. and 4,900 ft., involving long clearing through heavy timber. After these surveys by the railway engineers a triangulation survey was made in 1926 by Prof. Henry B. Alvord, of Northeastern University, Boston, Mass., using as a base line the first leg of the precise traverse. Instrument work in the headings of the 2.4-mile length of main tunnel east of the shaft resulted in closure errors of only 0.23 ft. in alignment, 0.20 ft. in elevation and 0.90 ft. in distance. In the 5.4-mile length west of the shaft these errors were 0.64 ft., 0.78 ft. and 1.0 ft., respectively.

Mill Creek Shaft—This intermediate shaft was adopted not only to expedite the work but with a view to dealing with the large amount of water that was anticipated. Thus in driving east from the shaft the work would be upgrade and water would flow to a sump at the shaft where pumps were provided. At one time these pumps were handling about 2,300 g.p.m. The shaft is 8x24 ft. and 621 ft. deep. It was sunk by drilling and mucking simultaneously, the mucking being done on an area of 8x12 ft., while drilling was in progress on a bench of the same size 3 ft. above it.

Its depth to subgrade is 622 ft., but it was sunk 659 ft. for the sump and to provide room for storage bins and loading pockets for the muck. In two of the four compartments, skips of 70 cu.ft. capacity were hoisted at a speed of 885 ft. per minute, handling about 140 tons per hour. A separate hoist handled men and materials and the fourth compartment was for the ladder, ventilation and air pump pipes.

Pioneer Tunnel—The pioneer tunnel, 8x9 ft., was started at the west portal, as noted above, but to save time by avoiding bad ground, an adit or drift about ½ mile east of the portal was started later, leaving the extension from the west portal, through bad ground, to be handled at slower speed. This drift, above and at one side of the tunnel line, was horizontal at first and then sloped down at 30 deg., striking the grade of the pioneer tunnel floor at about 2,280 ft. beyond the portal. The center line of this

TABLE IV—TUNNELING RECORDS

Tunnel	Cascade	Rogers Pass
Railway	Gt. Northern	Can. Pacific
Year	1926	1915
Pioneer bore; size	8x9 ft.	6½x8 ft.
Progress; one day	52 ft.	37 ft.
Progress; two days	90 ft.	68 ft.
Progress; three days	140 ft.	98 ft.
Progress; one month, Aug	937 ft.	932 ft.
Progress; one month, Oct.	1,157 ft.	.....
Center heading; size	10x10 ft.	.....
Progress, east end, one month, Sept.	984 ft.	.....
Enlarging heading, one month, June, 1927	1,064 ft.	1,030 ft.
Enlarging heading; one month, Aug., 1927	1,220 ft.	.....

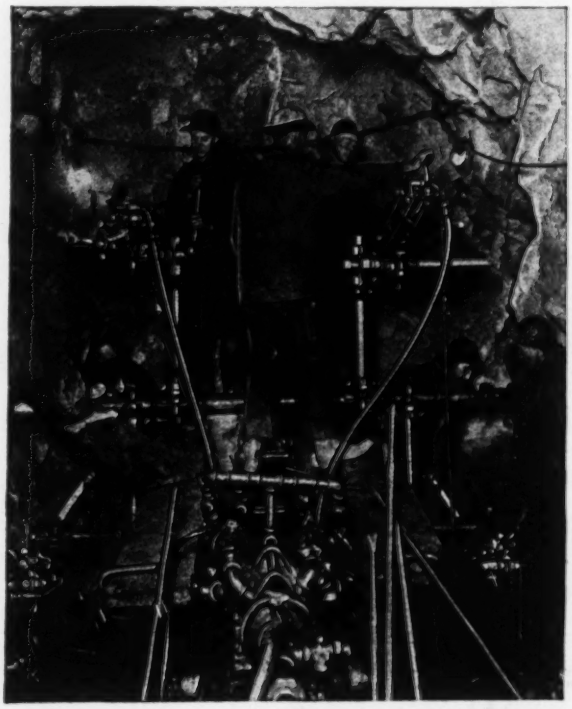


FIG. 5—DRILL CARRIAGE IN CENTER HEADING

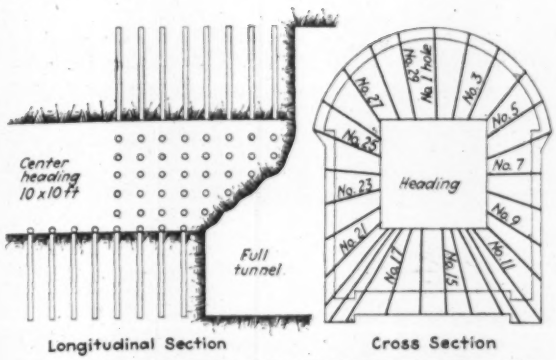


FIG. 6—DRILLING FOR ENLARGEMENT OF HEADING

tunnel was 66 ft. south of that of the main tunnel, this distance being considered ample to prevent any crushing of the rock rib between the tunnels.

Lateral drifts 8x9 ft. were driven diagonally to the line of the main tunnel to provide numerous points of attack for the headings. They were nominally about 1,500 ft. apart, but sometimes much closer, to suit working conditions. In all, there were 27 of these drifts, as shown on the progress chart in *Engineering News-Record* of Oct. 11, 1928, p. 555. At first the tunnel floor was level with that of the 10x10-ft. center heading, or 7 ft. above the floor of the main tunnel, but after water was struck at crosscut No. 5 the floor was dropped to the grade of the main tunnel.

Main Tunnel—As investigations indicated continuous solid rock, except for about 1,000 ft. at the west end, the center heading method of tunneling was adopted with enlargement by radial or ring drilling. At certain places, in shattered and seamy rock containing water under pressure, a top heading was driven in order to put in roof protection. In the longer stretch, west of the shaft, the drilling and mucking proceeded alternately; but in the shorter portion east of the shaft, where there was no pioneer tunnel, the operations proceeded simultaneously.

Work in the Center Heading—With the alternate system of working in the west portion of the tunnel, as soon as a mucking shift was completed and the loading machine removed, a drill carriage on 24-in. gage track was run up to the face and its bar was jacked against the sides of the heading. This bar carried four columns with swinging arms on which the drills were mounted. Drilling in this way is shown in Fig. 5. Under favorable conditions drilling could be started in 35 minutes after mucking was finished. In driving that part of the heading east of the shaft, the drills were mounted on bars, as a drill carriage could not be used on account of the ascending grade eastward.

A standard arrangement of drill holes was adopted to promote uniform progress, especially as shifts were changed at the face, so that a round was often begun by one crew and completed by another. However, these layouts (Fig. 7) were changed as required to suit varying conditions of the rock. When the round was completed, the drill carriage was run back while the holes were cleaned and charged and the electric light wires were removed. Then the drill carriage was run into a crosscut for protection while the blast was fired. For the pioneer tunnel, the length of holes for a round was about 313 ft., with 265 lb. of No. 60 dynamite. For the center heading, the holes aggregated 237 ft., with a charge of 250 lb.

In enlarging the heading to full tunnel section by ring drilling, all the 29 holes of each ring were drilled from one setting of the bar. The rings or rounds were 4 ft. apart. To facilitate correct setting of the drills, a red stripe was painted on the center line of the floor and a red mark on each side at 3 ft. above the floor or 7 ft. above the subgrade of the tunnel. For rapid mucking in the enlargement, power shovels were used, mounted on crawler tractions and operated by compressed air. These machines loaded 6-yd. dump cars hauled on tracks of 36-in. gage by 20-ton electric trolley locomotives. For enlargement at the west end, the radial drilling method was used to crosscut No. 7, or about 2 miles. Beyond this, three different methods were used according to the

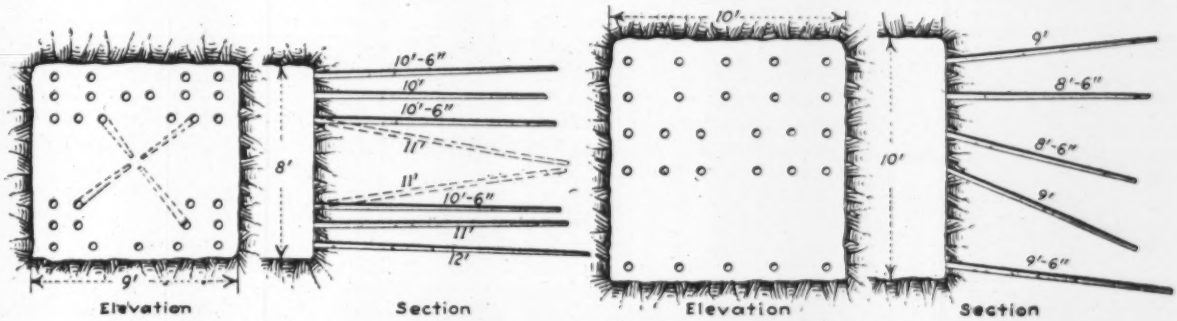


FIG. 7—STANDARD LAYOUT OF DRILL HOLES
At left—for pioneer tunnel. At right—for center heading.

FIG. 8—TIMBERED SECTION OF TUNNEL
View taken at time of heavy flow of water.

nature of the ground: (1) top heading, (2) center heading or (3) bottom heading.

Haulage in the pioneer tunnel and heading was done on tracks of 24-in. gage by steel dump cars of 50-cu.ft. capacity hauled by 6-ton electric trolley locomotives which carried wire wound on drums so that they could operate 500 ft. beyond the end of the trolley wires. Electric loading machines handled the muck. To avoid delays due to switching, an air-operated derrick car just behind the machine and on the empty-car track was used to lift an empty car over to the loading-track as soon as a loaded car was hauled away. The locomotive of the empty-car train then pushed another car up to the derrick car. For emergency purposes there were 6-ton locomotives having trolleys and storage batteries, so that they could be run if current failed or the wires were down.

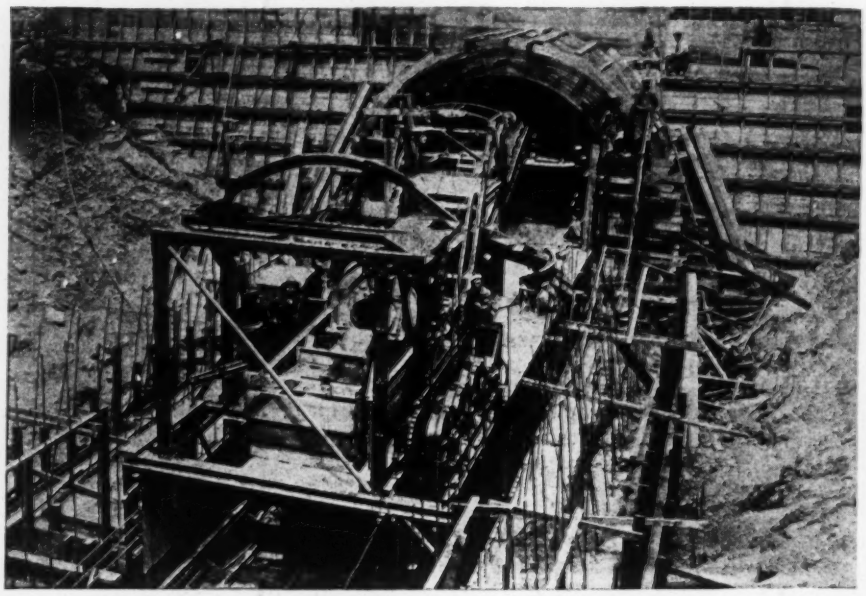


FIG. 9—MOVABLE CONCRETE PLANT FOR LINING THE TUNNEL
Eight of these plants were used.

Concrete Lining—Six portable concrete mixing and placing plants were used for this work, being mounted to straddle the 3-ft. construction tracks so as not to interfere with supply trains and mucking cranes. Batch boxes on flat cars were loaded at the portals. Collapsible steel forms facilitated the work and gave a smooth surface to the lining. The concreting was described in *Engineering News-Record* of Feb. 9, 1928, p. 224.

Relocation on Approaches—An important improvement of the division on which the Cascade tunnel is situated is 20 miles of relocation between Peshastin and Winton, east of the tunnel, to secure better conditions of grade and curvature. While the original line followed up the Wenatchee River, the new line follows its tributary, the Chumstick Creek, for part of the distance and then tunnels through the divide into the Wenatchee Valley. This line was opened Oct. 7, 1928.

Electrification—Electric operation has been adopted for the 75-mile division between Wenatchee and Skykomish, Wash., including the Cascade tunnel and Chumstick relocation. The old 2.63-mile tunnel was electrified in 1909, using the 6,600-volt contact system, but in 1927 this was changed to the 11,000-volt system and was extended west to Skykomish. This system, with motor-generator locomotives, was put into operation over the 75-mile division on Dec. 4, 1928, but using the old tunnel temporarily. Pantagraphs on the locomotives make contact with a wire suspended from a catenary or messenger wire attached to roof inserts in the tunnels and snowsheds, and to pole arms or span wires on open track. Maximum grades on this division are 2.2 per cent on both sides of the tunnel, with long stretches of 1.3 per cent on the east side and a continuous grade of 1.56 per cent through the Cascade tunnel. The locomotives are built in units of 700 tons capacity which are usually coupled in pairs. Two locomotives, or four units, can handle 2,900-ton freight trains on the maximum grades.

Track and Conduits—Track construction consists of 110-lb. rails with 8½x12-in. tie-plates on creosoted ties 7x9 in. and 8½ ft. long, spaced 24 to a 39-ft. rail length. Gravel ballast has its slopes retained by rows of hand-placed spalls along the edges of the track ditches, which are approximately 12 in. wide and 8 in. deep. From tunnel floor to top of rail the distance is 2 ft. These details of track construction in the tunnel are not shown in the sections in Fig. 3.

In each wall are weepers of 4-in. vitrified clay pipe just above floor level, and also inserts for electric lights about 6 ft. above the floor. In one wall are embedded 4-in. fiber conduits for signal, light and other wires, while in the other is a 3-in. galvanized-iron conduit for telephone and telegraph wires. All these conduits have pull-boxes at intervals. Trolley-wire supports in the roof are spaced 75 ft. c. to c. Refuge bays for trackmen, at intervals of 2,400 ft., are 8 ft. square in plan and have two creosoted sills on which to place hand-cars, while opposite the refuge the space outside the rail is covered with planking level with the ties. Alternating with these refuge bays and on the opposite side of the tunnel are recesses or bays 9½ ft. long and 4½ ft. deep back of the tunnel face, for transformers and other electrical apparatus.

Engineers and Builders—The tunnel has been carried out under the general direction of J. R. W. Davis, chief engineer of the Great Northern Railway, with Frederick Mears, assistant chief engineer, in direct charge, and M. J. C. Andrews resident engineer. The contract was let to A. Guthrie & Company, St. Paul, Minn., and the work has been under the supervision of J. C. Baxter, vice-president; W. E. Conroy was general superintendent (succeeding R. F. Hoffmark in 1927), with C. G. Jones, superintendent at Berne; H. G. King, at Scenic; F. J. Kane, at Mill Creek, and C. H. Taylor, on the Chumstick line. For the tunnel alone the cost was about $14,000,000, while the electrification of the division cost $6,000,000 and the Chumstick relocation $5,000,000, making a total of $25,000,000 for the improved crossing of the Cascade Range.

Old North Station at Boston Replaced by a Modern Structure Including a Coliseum

Former Station Kept in Operation During Construction—Terminal Facilities Concentrated on Ground Floor and Mezzanine Under Coliseum—Unusual Structure Features Involved in Design

By W. E. Belcher
Designing Engineer, Dwight P. Robinson & Company, Philadelphia, Pa.

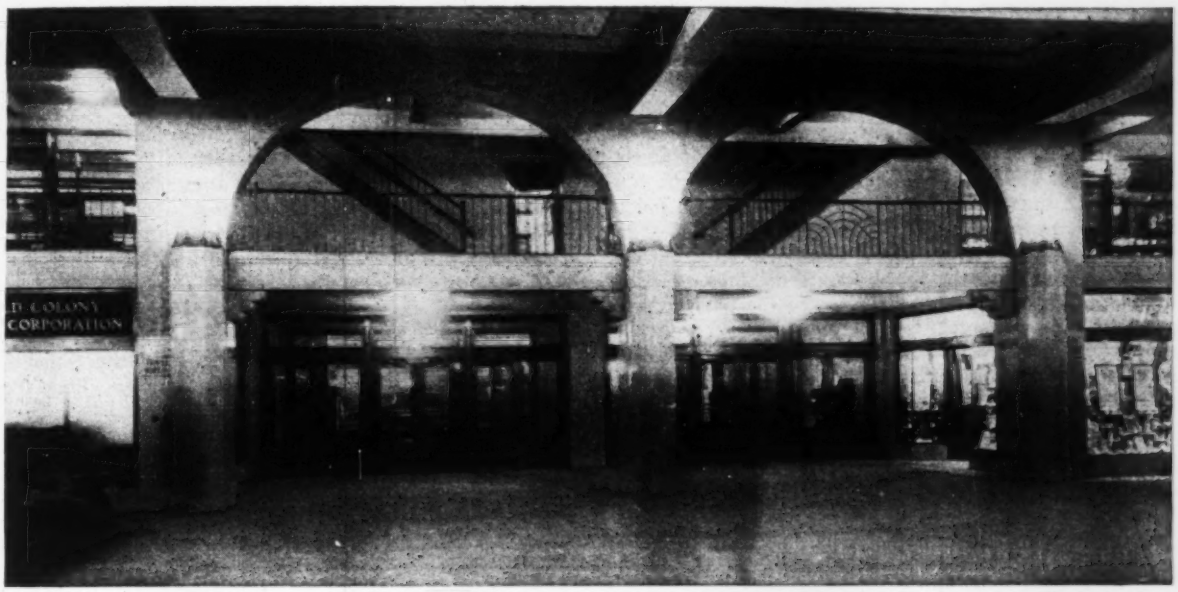


FIG. 1—LOOKING TOWARD THE STREET FROM THE WAITING ROOM
The full height of the station, main floor and mezzanine, is shown in this picture.

THE recently dedicated North Station of the Boston & Maine in Boston is unique in the utilization by the railroad company of the "air rights" above the station for the construction of a large coliseum practically identical with the present Madison Square Garden in New York City. Within a total height of 22 ft. from the station floor to the arena floor has been developed a modern passenger terminal station affording complete station facilities adequate for approximately 80,000 passengers per day. Above the arena floor level the coliseum construction, of an entirely different type, rises an additional height of 95 ft. The coliseum is connected with the station only through wide exit ramps at either end, these ramps forming an easy interchange for the public between the elevated railway stations, the arena floor level and the station floor level.

The general location of the North Station development is indicated on the accompanying plot plan (Fig. 2) covering the area between Beverley St. and Nashua St. and between Causeway St. and the Charles River. The station building herein described has a frontage on Causeway St. of 440 ft. with a depth of 170 ft. from the curb line to the train gates. The coliseum above has a length of 360 ft. with a depth of 205 ft., extending back over the train area about 35 ft. beyond the train gates. As the trains are steam operated, it was considered that the disposal of locomotive gases would present a serious problem if the building were to extend any farther out over the tracks, and this fact limited the width of the coliseum.

A three-story building 35x205 ft. along the Haverhill St. end is devoted to baggage space on the ground floor and offices and clubrooms for the Boston Madison Square Garden Corporation on the second and third floors.

In order to improve access by automobile to the building the city has purchased from the railroad company 35 ft. to be added to the width of Causeway St. and 52 ft. to be added to the width of Nashua St., making these streets 110 ft. and 92 ft. wide, respectively, which will greatly improve the approaches to the station.

The waiting room is approximately 40x260 ft. and the concourse 60x440 ft. Station facilities on the ground floor include the train announcement boards, ticket offices, information bureau, Western Union Telegraph Company, travelers' aid, parcel check room, baggage check room, express office, telephone room, New England States Exhibition spaces and various stores and rentals. On the mezzanine floor are located the ticket accounting office, travel bureau, Pullman office, Boston & Maine Transportation Company, motion picture display rooms, toilet and rest rooms, barber shop, beauty parlor and other rental spaces.

The coliseum above the railroad station has a seating capacity of approximately 18,000 for boxing events and 14,500 for hockey. The main arena floor is 110 ft. wide

and 245 ft. in length, on which ice can be formed when required. The seats are arranged around this arena in stadium form with one large balcony extending completely around the building and with an upper balcony along each side of the building. Ample stairways and exits at each corner of the coliseum provide full facilities, as required for theater construction, on the basis of 20 ft. in width for each 100 persons for whom seats are provided. In addition to these stairs, fire escapes are accessible from all levels.

Foundations—The site of the station was originally an arm of the Charles River, which extended beyond Haymarket Square. A dike was first built along the present line of Causeway St., cutting off this arm of the river. This was filled in about the year 1830 from material secured from the leveling down of Beacon Hill. Exploration for the foundations disclosed the depth of this fill and the underlying harbor bottom, below which very satisfactory bearing strata occur. A typical boring and pile record side by side are shown in Fig. 3.

The wood piles under the former Boston & Maine station, built in 1893, were found to be in excellent condition when uncovered, the tops of these piles being at El. 7 above mean low water. The builders of this earlier station used extensively huge granite blocks from adjacent quarries, and the split face on the under side of these blocks accurately fitted the top of the wooden piles without the use of mortar or concrete. The old sea walls, dock walls and other underground obstructions greatly increased foundation difficulties. The amount of rock excavated exceeded the amount of earth.

The presence of the underground obstructions necessitated special footing design to meet the conditions, which is indicated on the accompanying Fig. 4, showing the outline of the finished footings. In designing these footings where obstructions occurred the location of the piles as first driven formed the basis for locating the remaining piles in each footing in order to balance the center of the pile group, and on the basis of driving records footings were designed to suit actual locations. Concrete piles with cast-iron bases were used, carrying an allowable maximum load of 30 tons each without reinforcement. Tests of completed piles showed settlements of approximately $\frac{1}{8}$ in. at 20 tons load, $\frac{1}{4}$ in. at 40 tons load and $\frac{3}{8}$ in. at 60 tons load.

The location of the old rubble stone slip wall is shown on the plan, and through the center of this old slip an existing 5 ft. sewer had to be maintained. It was practically impossible to remove this old slip wall, as it could not be sheeted off in sections, no piles could be driven through it and to take it out meant excavating very large areas by clamshell, greatly disturbing the surrounding ground. Footings for one line of columns at the north of the building were placed after excavating a section of the wall, but elsewhere footings were bridged across the wall and sewer where necessary.

The firm of Charles T. Main, Inc., was called in as consulting engineer on the foundation work.

Structural Steel—The station portion of the building required approximately 1,200 tons and the remainder 2,700 tons of structural steel. As far as possible the new Carnegie beam sections were used not only for columns, beams and girders but for truss members and bracing.

The station steel was first erected and the concrete arena floor placed, which served as a working floor for the erection of the coliseum. Columns rest in all cases on steel billets which are grouted above the concrete piers.

Above the arena floor the wind pressure is carried to the bottom chord level and to the arena level by the columns in each bent. The bottom chord of the

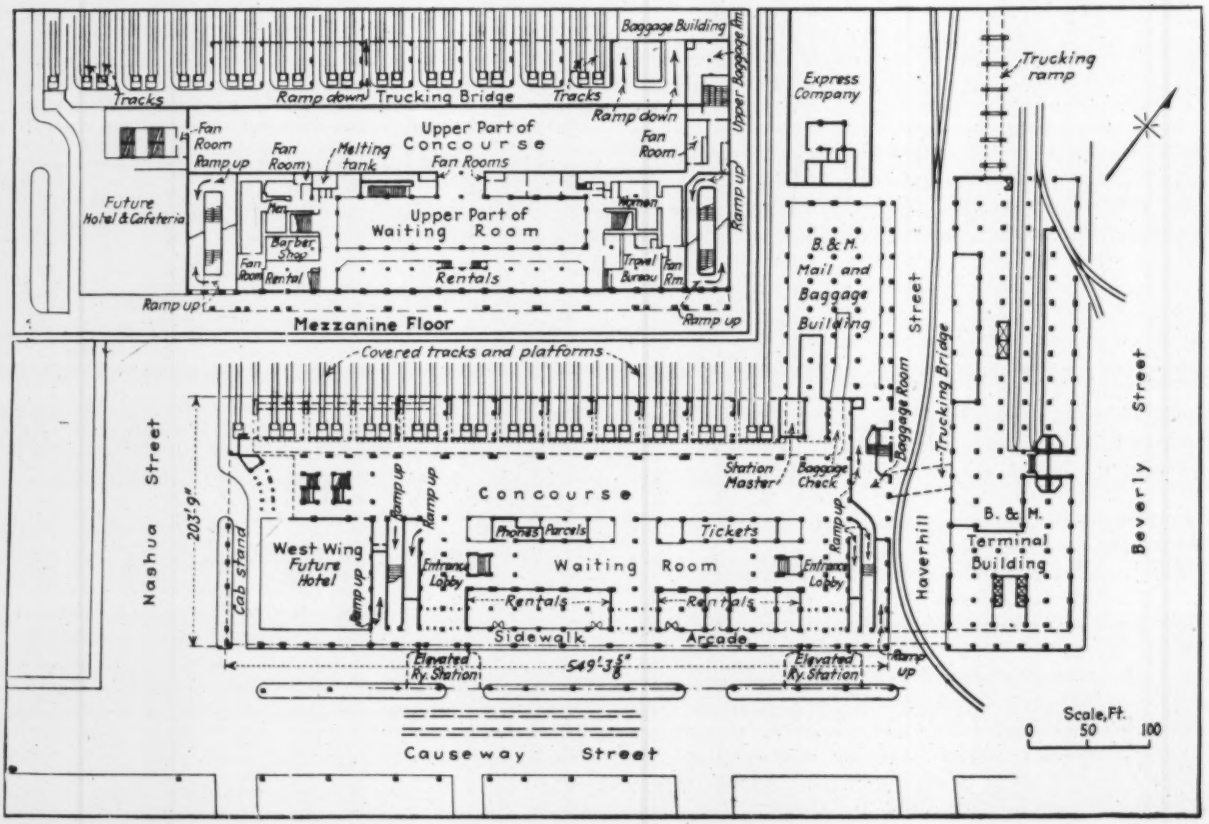


FIG. 2—PLAN OF BOSTON NORTH STATION

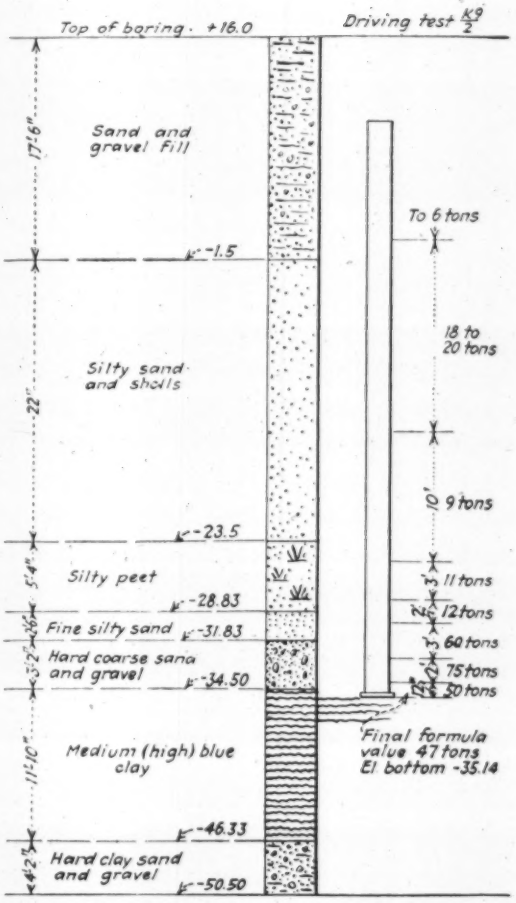


FIG. 3—SOIL BORING AND TYPICAL PILE RECORD

roof is braced along both sides and both ends so that all of the wind pressure taken at this level can be carried to the ends of the building, where the vertical bracing is adequate to take the wind load down to the arena floor. The concrete ramp walls at each end of the building absorb the wind pressure at this level. The stiffness of the seat banks after installation undoubtedly replaces the horizontal bracing to a large extent, but this was not considered in the design.

The spacing of the main columns 40 ft. on centers was practically dictated by the necessity of locating these columns in the platforms between passenger tracks, each platform serving two tracks. The baggage ramps are 5 ft. 6 in. in clear width, with a 7 per cent grade, located in the center of each platform. These ramps connect to a baggage runway over the train gates along the head of the tracks, handling baggage to and from the baggage room at the east end without interfering with passenger traffic. The main columns are located at the side of each ramp.

The 40-ft. spacing between roof trusses is spanned by 24-in. beams about 18-ft. centers. These carry at the third points 12-in. rafters, which in turn carry at their third points 6-in. purlins on 6-ft. centers. The total weight of roof steel with this design, including the walkways and bracings, is less than 20 lb. per sq.ft.

Design Loadings—The live loads used in the design are those specified in the Boston code for "assembly halls," a ruling as to the classification of this building having been obtained from the Building Department before commencing the design. The live load in general is 100 lb. per sq.in., covering passageways, stairs, foyers, halls and all of the seat banks. No allowance for live load reduction is made for this load in the design of floor beams, girders or trusses. A reduction is used in the column stresses as follows:

Carrying two floors, 25 per cent live load reduction
Carrying three floors, 40 per cent live load reduction
Carrying four floors, 50 per cent live load reduction

It was felt that where fixed seats occur such as in this case the specified live load was about double the probable maximum and that smaller requirement should have been permitted throughout the design. To open up the question, however, would have brought in the design of theater balconies and seating areas in general, including those where the fixed condition of the seats would be an open question. On this account it was thought unwise to ask for special ruling on this loading. Each seat occupies a width of 17 or 18 in. and a depth of 30 in.

The live load on the floors of offices, toilets, etc., is 60 lb. per sq.ft.

The construction of the arena floor to allow for the manufacture of ice involved a special allowance for both live and dead loads. This floor consists of the supporting slab reinforced both ways, on which 10 in. of patented floor construction is used, in which the refrigerating pipes are embedded. The total load on columns and girders from this construction is as follows:

Live load	100 lb. per sq.ft.
Concrete supporting slab	96 lb. per sq.ft.
Fireproofing of girders	11 lb. per sq.ft.
Structural steel	23 lb. per sq.ft.
Special ice floor	60 lb. per sq.ft.
Total	290 lb. per sq.ft.

To allow for concentrated loads to be expected when used for circuses the slabs and beams are designed for heavier live loads.

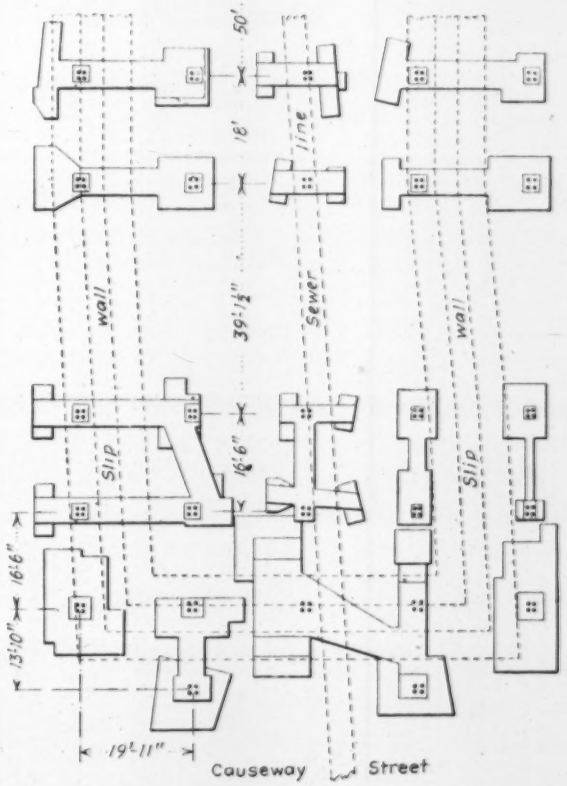


FIG. 4—OUTLINE PLAN OF PART OF FOUNDATION
Showing way in which footings had to be fitted around subsurface structures.

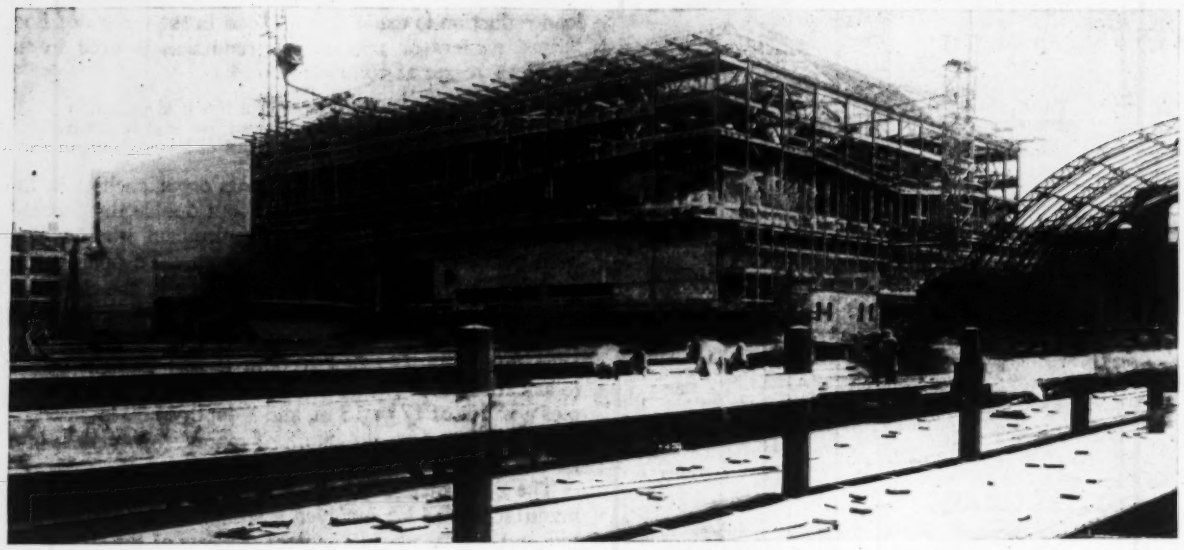


FIG. 6—REAR VIEW OF COLISEUM LOOKING OVER PLATFORM CANOPIES
Portions of the old station at the right. The concreting plant is located at the inner end of a pair of station tracks where materials can be delivered by rail.

The figured roof load is 80 lb. per sq.ft. total on the trusses, made up as follows:

Live load	40 lb. per sq.ft.
Sturctural steel	19 lb. per sq.ft.
Roof slab	14 lb. per sq.ft.
Roof covering	4 lb. per sq.ft.
Ducts, piping, etc	3 lb. per sq.ft.
Total	80 lb. per sq.ft.

The wind load on the vertical projection of the building is assumed to be 15 lb. for the first 80 ft. in height and 20 lb. for the height in excess of 80 ft.

Stresses—The stresses used following the Boston code comply very closely with the specifications of the American Institute of Steel Construction for the steel framing. The maximum value allowable in tension is 18,000 lb. and the maximum allowable compressive stress 13,500 lb. For combined stresses, including wind loads, the specified values may be increased 20 per cent.

The reinforced concrete was designed using a mixture of 1:2:4 stone or gravel concrete, in general using a maximum compression value of 700 lb. per sq.in. The reinforcing steel has a maximum stress of 16,000 lb. in all of the foundation work, concrete beams and girders throughout. In the floor slabs where steel bars are used the allowable stress is 18,000 lb. and where wire mesh is used 22,500 lb. per sq.in. All reinforcing bars are deformed and in the foundation work all bars have hooked ends in addition to the regular requirements for bond strength.

Concrete Seat Banks—The concrete seats and risers are 30 in. in width, the height depending upon the sight

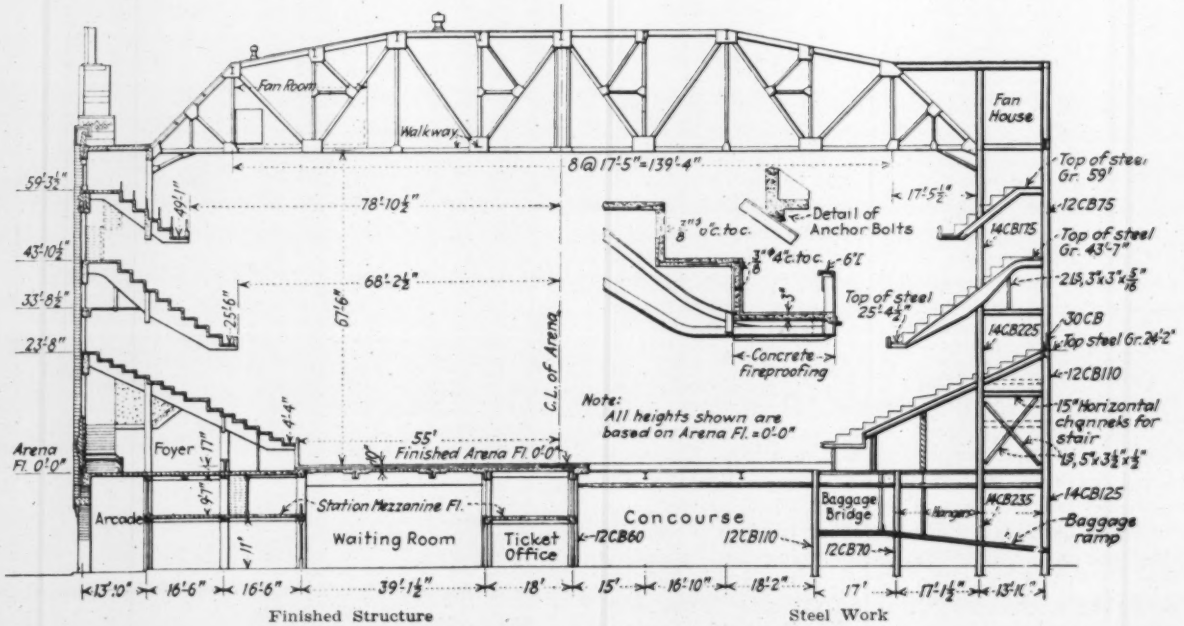


FIG. 5—CROSS-SECTION THROUGH COLISEUM AND STATION

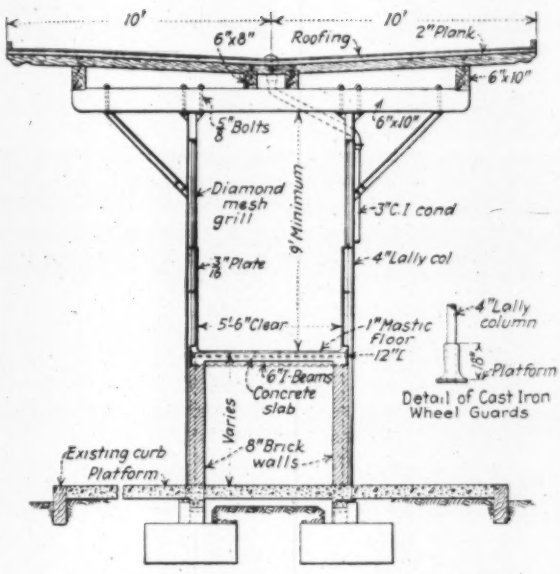


FIG. 7—CROSS-SECTION OF PLATFORM CANOPY THROUGH BAGGAGE RAMP

line requirement at each location. These concrete steppings are supported by the steel framework on about 20-ft. spans, the reinforcing in the risers being designed to carry the stepping horizontally between supports. Steps are 3 in. in thickness and risers 4 in., being cast with 1 : 4½ mix to obtain adequate shearing strength and to assist in working the material around the reinforcing and completely filling the forms. Special inserts for pipe sockets to take care of the pipe railings along the edges of the steppings were cast in the concrete. The chairs are bolted down with expansion bolts drilled into the slab.

Roof Construction—Before deciding on the type of roof construction, careful study was made by Clifford M. Swan, acoustical engineer, in order to insure a type of roof which would act as a sound-deadening element, making it possible to use the coliseum satisfactorily for various types of entertainment such as concerts, conventions, etc. The type finally adopted consists of a 1-in. thickness of compressed excelsior chemically treated so that it is both fireproof and sound absorbing. The results have been very satisfactory. Above this excelsior board a 2½-in. reinforced-gypsum slab was poured and covered with asbestos roofing material.

Finish—The exterior finish is of buff face brick carried out in strong vertical patterns, the pilasters being especially emphasized, presenting a modernistic exterior elevation.

The interior of the station is finished with terrazzo floor, marble wainscot and California stucco walls and ceiling. This stucco is tinted and textured for architectural appearance and the ceiling is paneled. These panels were laid out when designing the structural framing so that maximum headroom in the center of each panel is secured, as the plastering is directly on the bottom of the concrete slab. The ornamental lighting fixtures are attached to the ceiling at the center of each of these raised panels, giving a maximum height effect in the station.

The coliseum lobbies and foyers have terrazzo floors with plastered walls. The remainder of the interior is smooth surface terra cotta tile, in general painted to harmonize properly.

Stairs, corridors and concrete seat steppings are all given a monolithic concrete finish.

The roof trusses are painted aluminum color, the walls and facias light buff, all of the chairs being an olive green, the general effect in the coliseum therefore being light in tone.

Service Equipment—The heating and ventilating systems for the station and for the coliseum are entirely separate. In the station there are large fans at each end of the waiting room and concourse supplying fresh air, heated if required, to these rooms. From floor registers in the center of the waiting room a separate exhaust is provided to unit heaters delivering again to the center of the concourse. Direct radiation is used in all rental spaces.

In the coliseum the heating system has been designed to meet the variable conditions required for different gatherings, including boxing, hockey, concerts and conventions. Five large fresh air supply fans and eight exhaust fans in fan houses at the roof level are provided. The air supply is driven downward from the roof and exhausted at the arena floor and other levels, providing such clear air, even while the audience is smoking, that pictures can be taken and perfect visibility obtained from all parts of the house.

All of the air used for ventilation is filtered through oil-flushed air filters and then passed through heating stacks so controlled as to permit any desired temperature within the range of 40 deg. F. when the outside temperature is zero.

A system of caliscope temperature indication having 40 stations throughout the coliseum gives an accurate record of room temperature and relative humidity. The recording instrument is located in the engineer's room at the arena floor level.

The plumbing system has been carried out in accord-

FIG. 8—INTERIOR VIEW OF COLISEUM AFTER PLACING SEATS

ance with the best modern sanitary practice. The toilet rooms have tile wainscot and terrazzo floors. In the station the men's toilet and the women's toilet are on the mezzanine floor at opposite ends of the waiting room, being operated on the pay turnstile principle in general.

In the coliseum the upper balconies have received the same consideration as the arena and mezzanine levels, with complete facilities for men and women, and wherever possible the women's toilets have been provided with an adjoining lounge room.

A complete system of fire protection is provided, permitting fire fighting from any level from at least six points at each level.

The arena floor has been equipped with a complete brine-piping system to provide an ice floor surface for ice hockey and public skating. Brine for this system is delivered through 10-in. supply and return mains from a refrigeration plant on Minot St. The ice floor requires 13 miles of 1¼-in. piping on 4-in. centers embedded in a special concrete floor surface. If it is required, ice can alternate with other events not requiring ice on successive evenings. The concrete finish containing these pipes is entirely separate from the supporting slab underneath and from the arena walls on all sides, so that the entire floor is free to expand or contract independently of the main structure.

Electrical Facilities—The electrical energy is purchased at 4,000 volts, three phase, alternating current and 230/115 volts direct current. The alternating current goes through transformer banks in various sections of the building, where it is reduced to a working voltage of 220 volts three phase for power and 115 volts single phase for lighting. The direct current is distributed by feeders to the equipment throughout the building, being used for power, exit lighting and emergency lighting. The lighting load amounts to 525 kva. and the power load to 600 kva., being used principally for battery charging and to drive the large ventilating fans and other miscellaneous motors that are installed throughout the building.

The operating center of the station is located in the station master's office. At this point the telegraph lines are centered for handling the train dispatching and railroad business and also the intercommunicating house telephone system, connecting with instruments distributed throughout the station. The master telechron electric clock controlling the station time system, the central fire alarm board connecting the station fire alarms into the city fire alarm system, and the code call are located here. The telautograph instruments are controlled through the instrument in the station master's office, from a master sender in the railroad yard.

Telephone and telegraph rooms for the use of the public are located adjacent to the waiting room, with phone booths distributed throughout the station.

In the coliseum is also a house telephone system and outside switchboard. In the arena are special electric clocks mounted on the front of the two side balconies for boxing events, giving not only the time but also the number of rounds automatically. Also on the end balconies are electrically operated clocks for scoring and timing hockey games. Connections for press telegraphers are provided at the front of the balconies and also at the ringside, where the connections are concealed beneath the surface of the floor.

An amplifier hung from the center of the building can be operated from the ringside, from the balconies or from the engineer's room, distributing music or the human voice so that the sound is easily heard throughout the building.

Progress—The building was constructed without serious accident either to the public or employees, although construction was specially hazardous because all of the old station buildings were wrecked and the new building was constructed while full passenger traffic was maintained. Demolition began Dec. 3, 1927, at the east end, but the westerly portion was not released for wrecking until Jan. 9, 1928. The new station was occupied Aug. 20, 1928, and the opening event in the coliseum was held Nov. 17, 1928.

Personnel—The work on the North Station and Coliseum was carried out under W. J. Backes, chief engineer, with the direct supervision of F. C. Shepherd, consulting engineer, of the Boston & Maine Railroad. The architects on the station facilities and the exterior of the building were Fellheimer & Wagner, New York, while the Funk & Wilcox Company, Boston, had charge of the architecture and design of the coliseum. The construction work was carried out by Dwight P. Robinson & Company, Inc., a constituent of the United Engineers & Constructors, Inc., through B. S. Thayer, superintendent, and the author as designing engineer.

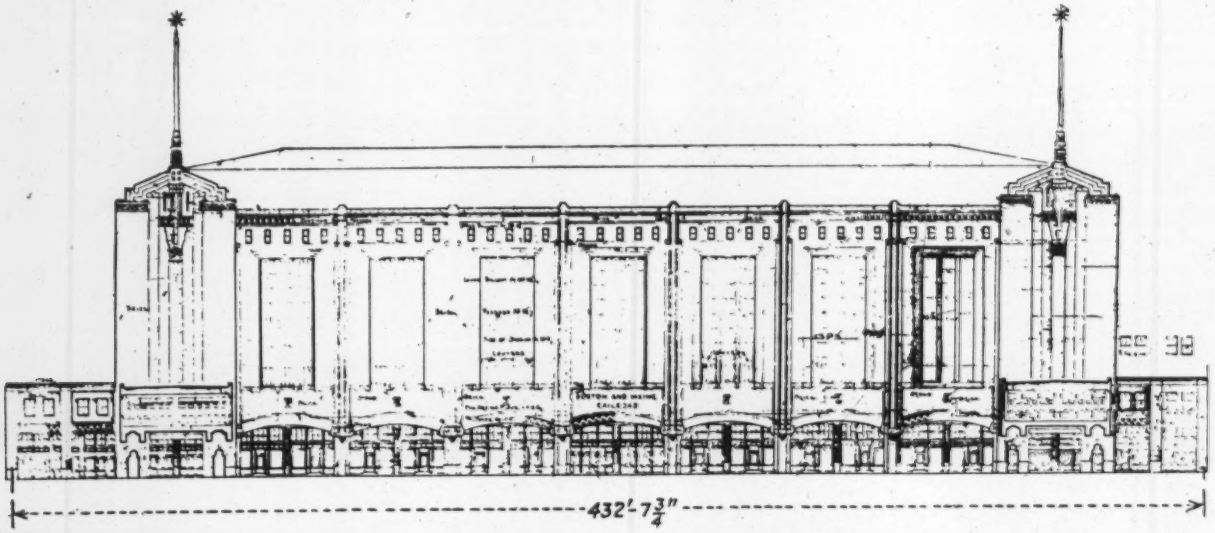


FIG. 9—ARCHITECT'S DRAWING OF THE CAUSEWAY ST. FRONTAGE

Steel and Concrete Ties: Present and Future

Review of Substitutes for Wood Ties on American Railways—Prospects for Future—Need of Engineering Study—The Situation in Other Countries

By E. E. R. Tratman
Western Editor, Engineering News-Record

EXCEPT for a stone-block period in the early days of American railways, the universal form of support for the rails has been, as it is today, the wood cross-tie which both supports and connects the rails. The wood tie has not held its place unchallenged, for the history of railway track development records innumerable proposed substitutes of metal, concrete and other materials which have been invented, patented and even tried in the track. But the challenges have been weak and ineffectual and have utterly failed of their purpose in the production of practicable and commercial competitors of the wood tie. Some 750 designs of what are now classed as "substitute ties" were patented during the period 1840-1894, as shown in a report by the writer to the U. S. Department of Agriculture in 1894. Since then the patents have been probably even more numerous; but the vast majority of them have never passed beyond the paper stage. This situation is discussed editorially on p. 333 of this issue.

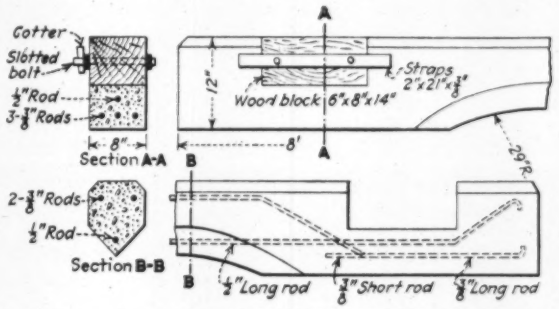


FIG. 1—INDESTRUCTIBLE CONCRETE TIE, SOUTHERN PACIFIC LINES

Designs for substitute ties have been produced mainly through inventive faculty, rather than upon the basis of scientific study or a knowledge of the conditions requisite for a successful design, so that few designs have attained to actual manufacture or trial. Many were so complicated in themselves or in their rail fastenings as to be of prohibitive cost even if practicable, their designers having no understanding of manufacturing processes or costs, track construction, service railroad requirements or economic principles. However, limited trials of substitute ties and indefinite knowledge as to their results do not constitute strong arguments against their possible value. It is to be noted in this connection that as yet railway executives and railway engineers in general have taken small interest in the subject and have rendered little assistance or guidance toward the development of practicable designs.

Present Situation

Practical Tests—Although consideration of substitute ties, or ties made from some other material than wood, has been checked considerably within the past ten or fifteen years by the great economies and increased supplies of wood ties resulting from the extensive use of preservative treatments, there are still several kinds

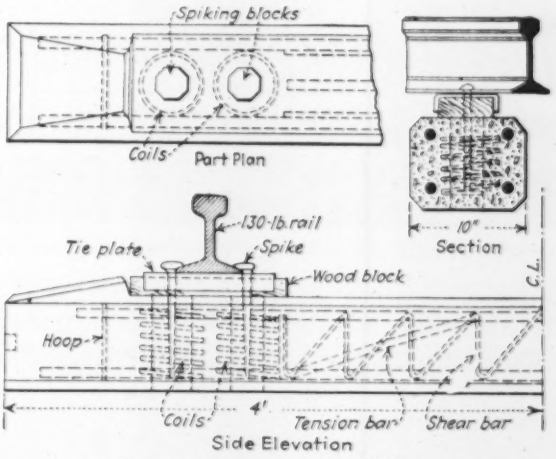


FIG. 2—CASEY CONCRETE TIE, PENNSYLVANIA RAILROAD

of steel and concrete ties in use. The substitutes, however, are mainly experimental and in small lots. Few have been laid in recent years, the only notable recent activities being the introduction of about 25,000 concrete ties by the Pennsylvania Railroad and about 13,000 steel ties by the Delaware & Hudson Railroad. The former are laid largely in main-line freight tracks, whereas the latter, made from scrap rails, are laid principally in side tracks.

Records of trials of substitute ties have been kept by the tie committee of the American Railway Engineering Association for several years, and the accompanying table includes its figures for 1928. The items of the Delaware & Hudson Railroad and the Delaware, Lackawanna & Western Railroad have been interpolated, as these roads are not mentioned in the committee's report. Furthermore, these annual reports simply describe individual experiments and give no review or analysis of the experience or results with substitute ties as a whole. In 1910 that committee listed 26 railroads with about 39,000 ties, and in 1922 it showed nineteen roads with 45,504 ties in use out of 51,322 laid between

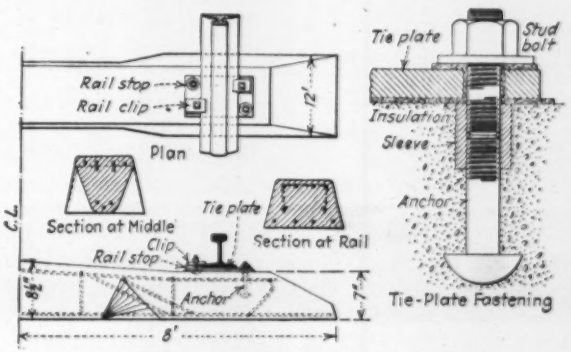


FIG. 3—HATCH CONCRETE TIE, DULUTH & IRON RANGE RAILROAD

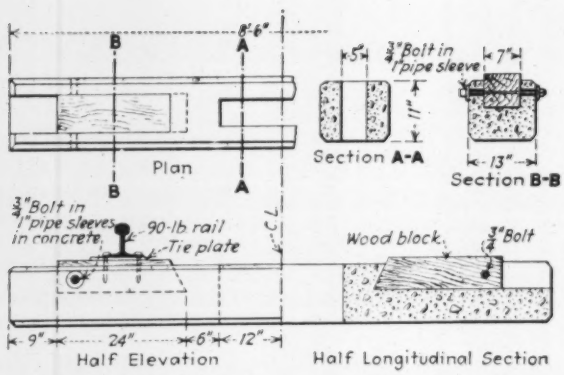


FIG. 4—DUKE CONCRETE TIE, ATLANTA & WEST POINT RAILROAD

1903 and 1920. In 1927 the record had dropped to nine roads having 32,556 ties left out of 51,256 originally placed. As the accompanying table for 1928 includes the recent developments on the Delaware & Hudson Railroad, the Pennsylvania Railroad and the Delaware, Lackawanna & Western Railroad, its totals amount to twelve railroads with 66,029 ties in use out of 81,310 ties laid between 1905 and 1928. Of this total, 38,535 are steel ties, 25,423 are of concrete and 2,071 are composite ties. Troubles reported include wear of steel or concrete surfaces, cracking of steel, disintegration of concrete, unsatisfactory rail fastenings, and lack of electric insulation for track circuits. In many cases the tie itself and its rail fastenings are complicated and costly, requiring much shop work and many special parts.

Substitute ties may be divided into three classes: (1) concrete ties, (2) steel ties, (3) composite ties made of both concrete and steel, the steel being exclusive of ordinary reinforcing material. The second class includes ties made by railroads as a means of utilizing scrap rails. But although many railroads manufacture a variety of articles from concrete, it is not known that any of them include concrete ties.

In 1925 the tie committee mentioned above submitted designs for composite ties to be made from commercial steel channels and recommended that railways should make and try these, but it does not appear that any has been manufactured. The tie (see *Engineering News-Record*, May 7, 1925, p. 770) was to consist of an inverted channel, with wood blocks on top to carry the rails and with a long filler block of wood or concrete inside at each end, all parts being held together by bolts having clips for the rail fastenings. The committee expressed its opinion that while no substitute tie could then compete with the treated wood tie on an annual-cost basis, it was desirable to develop a satisfactory design in view of possible changes in the relative prices of wood and substitute materials.

Substitute Ties in Service

Turning now from the general situation to specific examples of substitute ties in actual use, it will be both useful and interesting to describe briefly the several types of substitute ties now in service, disregarding designs that are no longer in use and experiments that have been discontinued. From examination of the records it appears that out of the various ties laid for experiment only about sixteen designs are included in the 66,000 ties noted above as being in track. Even a few of these designs are already definitely abandoned and the removal of the ties from the track will be the final end of the designs. But as they are in use, they are included in the following descriptions. This review relates only to ordinary steam railway service and does not include the use of concrete or steel ties for street railways, mine tracks and industrial or portable railways.

SUBSTITUTE TIES IN SERVICE: 1928

Railroad	Tie	Material	Date Laid	Number Laid	Now in Track	Ballast	Rail Lb. Per Yd.	Traffic
Atlanta and West Point	Duke	Concrete	1927	10	10	Stone; gravel	90	Passenger and freight
Bangor & Aroostook	Maine	Concrete and steel	1923–24	69	69	Gravel	85	Passenger and freight
Delaware & Hudson	Dalton	Steel	1927–28	13,000	13,000	Cinder	80	Side tracks
Delaware, Lackawanna & West.	Silver	Steel	1928	15	15	Stone	105	Switching; slow freight
Duluth & Iron Range	Hatch	Concrete	1923	11	11	Gravel	80	Freight only; heavy
Duluth & Iron Range	Carnegie	Steel	1905	2,000	1,045	Gravel	80	Freight only; heavy
Duluth, Missabe & Northern	Kimball	Steel	1914	30	30	Gravel	100	Freight only; heavy
Duluth, Missabe & Northern	Carnegie	Steel	1908–09	22,380	20,087	Stone	100	Passenger and freight
Elgin, Joliet & Eastern	Bates	Concrete and steel	1912	62	62	Gravel	85	Freight only; heavy
Elgin, Joliet & Eastern	Carnegie	Steel	1906–16	15,514	4,127	Grav., cin., slag	85; 100	Freight only; heavy
Elgin, Joliet & Eastern	Carnegie, switch	Steel	1912–27	(Note)	(Note)	Grav., cin., slag	80; 85	Yard; heavy
Long Island	Carnegie	Steel	1909	30	6	Cinder	100	Passenger and freight
Lond Island	King	Concrete	1924	33	33	Stone	100	Slow; passengers only
Pennsylvania	Casey	Concrete	1925–28	25,374	25,346	Stone; cinder	130	Main line and yard
Pennsylvania	Riegler	Concrete and steel	1908	15	15	Stone	130	Passenger and freight
Pennsylvania	Snyder	Concrete and steel	1907	2,255	1,856	Cinder	100	Yard; light
Pennsylvania	Silver	Concrete and steel	1922–24	164	69	Cinder	130	Freight; heavy
Southern Pacific	Indestructible	Concrete	1916–26	123	23	Gravel; cinder	80; 90	Main line; heavy
St. Louis–San Francisco	Clark	Steel	1914	125	125	Chats	85	Freight; heavy
Terminal R.R. of St. Louis	Miller	Steel	1924	100	100	Stone; cinder	100	Passenger and freight
Totals				81,310	66,029			

Note—Steel switch ties laid in 1912 and later aggregated 525,842 lin.ft., of which 86,447 ft. were in track in 1928.

Reinforced-Concrete Ties

In practically all the concrete ties and the concrete portions of composite ties there is some form of steel reinforcement for the concrete.

Casey Concrete Tie—This reinforced-concrete design

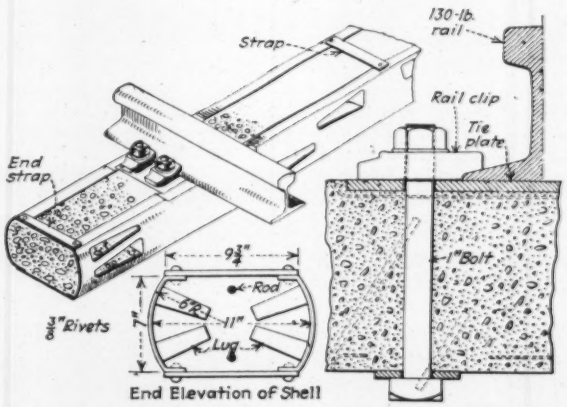


FIG. 5—RIEGLER COMPOSITE TIE, PENNSYLVANIA RAILROAD

is notable for the large number in use, 25,346, all on the Pennsylvania Railroad. But they are of very recent application. In 1925 about 400 ties were placed near Pittsburgh, Pa., and are still in service. In 1927 the railroad purchased 25,000, of which 17,500 were laid that year and the remainder in 1928. They are laid in stretches of about a mile in length, largely on main-line freight tracks.

This tie (Fig. 2) is of rectangular section, 8x10 in., 8 ft. long, with the ends raised as shoulders to prevent lateral shifting of the 1¾-in. creosoted oak bearing blocks, which are 5x14 in. On each block is a channel-shaped steel tie-plate. The rail, tie-plate and block are held by two spikes, 9 in. long under the head, driven into octagonal wood blocks embedded in the concrete. These blocks are of creosoted oak, 2¾ in. over the sides and 8 in. long. Steel reinforcement includes longitudinal top and bottom bars, rectangular hoops, inclined tension bars and zigzag shear bars, together with four spiral coils around the spiking blocks. Defects reported in a few ties after inspection include slight and serious cracks, fracture, crushing, disintegration and spalling. These ties are made by the Concrete Tie Company, Pittsburgh, Pa.

Indestructible Concrete Tie—These ties (Fig. 1) in use on the Texas lines of the Southern Pacific Railway, are of gravel concrete, 8 ft. long, 8x12 in. at the ends, but with recesses in the top 6 in. deep for two wood spiking blocks. At the middle the depth of the tie is reduced to 10 in. by a curve in the bottom, and the curved portion is of wedge section to prevent the tie from becoming center-bound in the ballast. Of these ties, 23 were laid in 1916 and 100 in 1926. The first are in good condition, but all of the latter lot are reported as having been removed in 1927, owing to their failure by cracking through the middle and the difficulty in holding the rails to gage on the oak blocks. This tie was designed by F. C. Shearer, engineer for the U. S. Indestructible Tie Manufacturing Company, Eagle Pass, Tex.

Hatch Concrete Tie—This tie (Fig. 3) as used on the Duluth & Iron Range Railroad, is 8 ft. long, 8 in. wide on top and 12 in. wide on the bottom for the end portions, but of V-section at the middle. The bottom is level, but the top is crowned between the rails, increasing the depth from 7 in. at the rails to 8½ in. at the middle. For each rail there is a tie-plate having two bolts at diagonally opposite corners, each bolt having a flat washer or rail stop to bear against the edge of the rail base, with a separate rail clip upon this and secured by a nut. Thus the rail is directly fastened only to the tie-plate. This plate in turn is anchored to the tie at each of the other corners by a stud bolt engaging a threaded iron sleeve in the concrete. The sleeve has a bolt screwed partly into it, these anchor bolts and the sleeves being embedded in the tie. Of the ties in use, seven were reported in good condition in 1928, whereas four showed disintegration of the concrete.

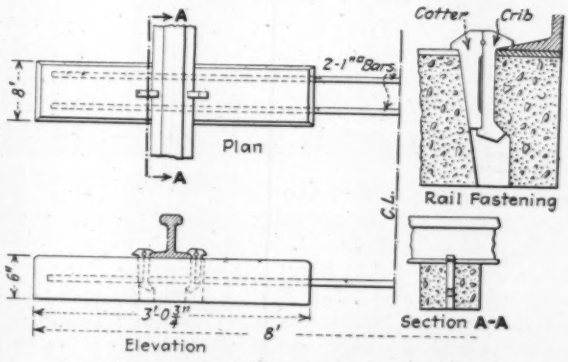


FIG. 6—MAINE COMPOSITE TIE, BANGOR & AROOSTOOK RAILROAD

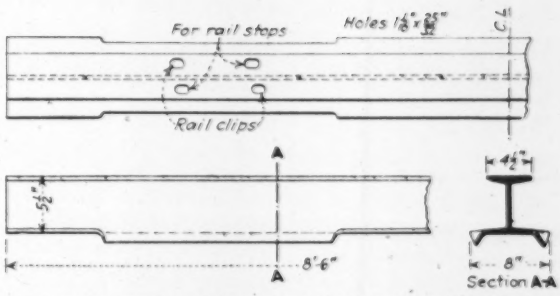


FIG. 7—STEEL I-BEAM TIE; DULUTH, MISSABE & NORTHERN RAILWAY

Duke Concrete Tie—In this tie (Fig. 4), which is of large cross-section, 11x13 in., the ends are recessed to form channels for large wood blocks to which the rails are spiked. A middle opening, 5x24 in., entirely through the tie, is designed to prevent center-binding in the ballast. Each block is secured by a dovetail fit in the recess and by a ¾-in. bolt passing through 1-in. pipe sleeves in the concrete. Ten of these ties were laid in 1927 on the Atlanta & West Point Railroad, according to the committee's report.

Composite Concrete-Steel Ties

Riegler Composite Tie—In this design (Fig. 5) the reinforced-concrete core has on each side a steel channel with convex web, lugs stamped out of the web, making a bond with the concrete. Through bolts are used with rail clips, so that the ties can be inverted if desirable. The fifteen ties made on the Pennsylvania Railroad to the design of L. J. Riegler, assistant engineer, have been in use in heavy-service high-speed main track since May, 1908, except that some of them have been taken out occasionally for patching defective portions of the concrete, which repair work has proved successful (see *Engineering News-Record*, March, 22, 1928, p. 480).

Snyder Tie—This tie consists of a steel plate bent to form a bottomless box filled with asphaltic concrete, into which the spikes are driven. Of 2,255 ties laid on the Pennsylvania Railroad in 1907, there were 1,856 remaining in 1928, the removal being on account of the concrete crushing and disintegrating. However, the inventor has abandoned this design in favor of a rolled steel tie.

Maine or Smith Tie—This composite tie (Fig. 6) consists of two reinforced-concrete blocks 3 ft. long and 10x6½ in. in section connected by two 1-in. tie-rods 7 ft. 10 in. long, having their ends embedded in the concrete. The ties in use on the Bangor & Aroostook Railway for five years and reported in good condition in 1927 are 8 ft. long. The concrete mix is 1 : 1½ : 1½, using ¾-in. gravel for the coarse aggregate. Holes of special shape are made to secure the rail fastenings. A channel-shaped gib or clip has one flange fitted over the rail base and the other over a seat formed in the concrete. A taper key is driven behind the gib until semicircular grooves in the two parts register to form a ¼-in. hole for a pin which locks the parts together. The ties were de-

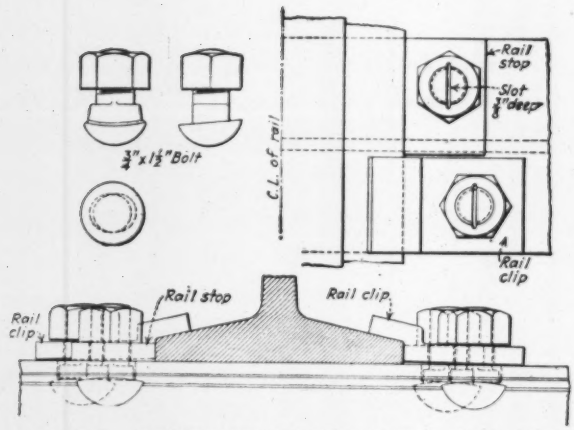


FIG. 8—RAIL FASTENING FOR STEEL TIE, D., M. & N. RAILWAY

signed by Sidney S. Smith, president of the Maine Concrete Railroad Tie Corporation, Corinna, Me.

Bates Tie—This is similar to the preceding or Maine tie, being composed of a pair of flat reinforced-concrete blocks 7½x9x34 in. but instead of using tie-bars the blocks are connected by two shallow trusses formed by slitting and expanding the webs of rolled steel members. These trusses extend through the blocks and serve as part of the reinforcement. One form of fastening consists of a hook spike entering a cored hole in the tie and engaging a part of the steel, being secured in place by a wooden wedge driven behind it. In a modified design, a hook bolt engages the steel and is fitted with a rail clip and nut. This bolt is backed by a wooden wedge the top of which projects above the tie so that the rail clip rests upon it. The ties placed on the Elgin, Joliet & Eastern Railway by the Bates Expanded Steel Truss Company, East Chicago, Ind., in 1912 were reported by the railroad as being in good condition in 1928. They were made as an experiment and the company does not now manufacture them.

King Composite Tie—This consists of two concrete blocks 36 in. long and 8 in. square connected by a single 1¼-in. tie-rod having a threaded sleeve joint to allow of gage adjustment. In June, 1924, the Long Island Railroad laid 33 ties made by the King Foreign Cross-Tie Company, New York, but the railroad gives no particulars of their present condition and the makers cannot be located.

Silver's Composite Tie—An unusual arrangement of the rail supports characterizes this tie, which consists of two oblong skeleton frames of cast steel filled with concrete and connected by a tie-bar. The rails rest on wood blocks and are held by bolts which are insulated from the steel frame. As the oblongs are laid with their longer dimensions parellel with the rails, each tie takes

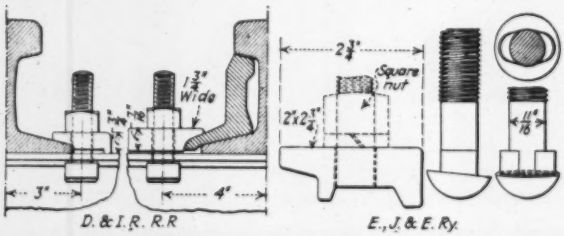


FIG. 9—RAIL FASTENINGS FOR I-BEAM TIES
At left, Duluth & Iron Range Railroad. At right, Elgin, Joliet & Eastern Railway.

the space of about four wood ties. Such ties laid on the Pennsylvania Railroad in 1922 are reported as proving unsatisfactory, although in one installation there were four wood ties between each pair of substitute ties. The fourteen ties shown in the table as laid in 1924 are said to be of improved design and in 1928 were reported in good condition, although a few appeared to be cracking. They were designed by J. H. Silver and furnished by the Permanent Railway Tie Corporation, New York.

Steel Ties

Steel I-Beam Tie—The form of tie which has been used most extensively is a rolled-steel shape of I- or H-section with bolted fastenings. This tie was designed originally by Charles Buhrer, a roadmaster on the Lake Shore & Michigan Southern Railway (New York Central Lines), and gave such promise of good results that it was adopted about 1905 by the Carnegie Steel Company as one of its products. But although large numbers have been laid, this design is going out of use, those taken out for defects or failure not being replaced with steel, as is shown conclusively by the annual rec-

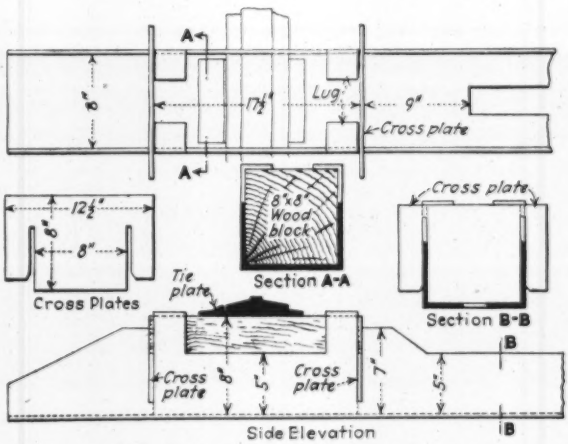


FIG. 10—CLARK STEEL TIE, ST. LOUIS-SAN FRANCISCO RAILWAY

ords of the tie committee, already mentioned. Wear, corrosion and ineffective rail fastenings seem to be the main troubles, combined with difficulties in insulation to prevent leakage of electric current where track circuits are used. Reports of removals mention breakage, corrosion, distortion of flanges, buckling of webs and crushing of webs under the rails. On some of the railroads all of these ties have been removed. Four railroads still had them in 1928, the number aggregating 25,265 out of 39,924 laid between 1905 and 1916.

The tie as used on the Duluth, Missabe & Northern Railway (Fig. 7) has a 4½-in. top flange and 8-in. bottom flange, with a depth of 5½ in. in the body and 6⅛ in. where the bottom flange is bent downward to anchor the tie in the ballast. The length is 8½ ft. and the weight is 20 lb. per foot. In the R. H. Clark patented fastening used on this road (Fig. 8) there are four short bolts at each rail, with slotted ends and with button heads shaped to fit the inclined face of the tie flange. Only two of the bolts hold rail clips, however; the others hold flat washers or rail stops which fit against the edge of the rail base to prevent lateral shifting or slewing.

The I-beam ties on the Duluth & Iron Range Railroad are of the same section and 8 ft. long, but the bottom flanges are left straight and anchorage in the ballast

is provided by two semi-elliptical lugs formed by cutting the web and bending the pieces outward on opposite sides of the tie. Long squarehead bolts have rail clips and nuts (Fig. 9), the clips at the railjoints engaging the flanges of the splice bars. On the Elgin, Joliet & Eastern Railway the ties are 8 ft. long and of the same section, with straight bottom flanges, but without the web anchors. Bolted clips of a different shape, also shown in Fig. 9, form the rail fastenings, the bolts having oval necks to fit slotted holes in the ties. It is of interest to note that this road has made extensive use of steel switch ties of varying lengths for turnouts, in busy yards, as shown by the table.

Clark Steel Tie—This tie (Fig. 10) is a steel channel with closed bottom and having two creosoted wood blocks 17½ in. long, to which the rails are spiked. These blocks are held down by lugs bent over from the sides of the channel and are held in place by removable transverse plates slotted to fit over the sides of the channel, the projecting ends of these plates serving as anchors to prevent shifting of the tie in the ballast. The tie is a modification of a type frequently designed and patented. The 125 ties laid on the St. Louis-San Francisco Rail-

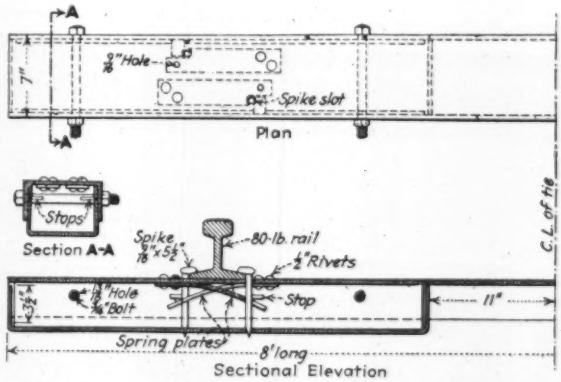


FIG. 11—KIMBALL STEEL TIE, DULUTH, MISSABE & NORTHERN RAILWAY

way in 1914 were all in service in 1928, but the wood blocks are found to last only six or seven years and the steel lugs will not stand continual bending for renewal of the blocks. It is reported by the railroad that the track having these ties requires less work for maintaining line and gage.

Kimball Steel Tie—In this built-up steel tie (Fig. 11) as used on the Duluth, Missabe & Northern Railway, the top member is an inverted 7-in. ship channel 8 ft. long, weighing 15.6 lb. per foot. Under and within each end is a box with closed ends, formed by bending a ¼-in. plate that has been cut to special shape. Two horizontal bolts secure the box to the channel. A curious rail fastening consists of ordinary spikes driven through slots in the channel and engaging slotted spring plates inside the tie. Each plate is 2x10 in., with one end riveted inside the top of the tie while its free end is held down by a stop so that the spring is in tension. The friction of the plate against the face of the spike affords the holding power. As the tie is only 4½ in. deep, the bottom is punched with holes to allow the 5½-in. track spikes to pass through. All the ties were reported in good condition in 1928.

Silver's Cast-Steel Tie—This tie (Fig. 12) has the unusual feature of being composed of two steel castings connected by a tie-bar. It is similar in principle to the Silver composite tie on the Pennsylvania Railroad

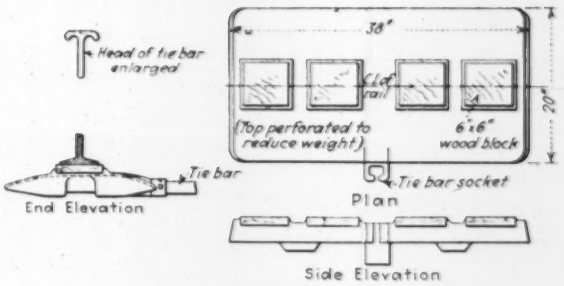


FIG. 12—SILVER CAST-STEEL TIE, DELAWARE, LACKAWANNA & WESTERN RAILROAD

(noted above), but has no concrete. The castings, 38x20 in., are laid lengthwise of the rails and the flat tee-headed tie-bar, set on edge, is secured to lugs on the castings by means of keys. In general, the design resembles a type of tie used extensively in India. Four sockets in the top receive wood blocks about 6 in. square and 2 in. thick, upon which the rail rests. Rail clips are secured by stud bolts passing through them into brass nuts fitted to sockets in the casting and having fiber bushings. These nuts are trumpet shaped, so that they cannot be pulled out from the top of the tie. As laid in a switching lead on the Delaware, Lackawanna & Western Railroad, in September, 1928, there are eight ties to a rail length, spaced about 4 ft. c. to c.

Ties Made From Old Rails

Numerous designs have been made for ties of this type with the idea of enabling railways to make their own steel ties by utilizing scrap rails. Their cost is difficult to determine owing to the shop work required and the variations in market price of scrap. Two such designs are now in service.

D. & H. Tie—On the Delaware & Hudson Railroad, with the assistance of William Dalton, of the General Electric Company, a tie has been developed (Fig. 13) consisting of a pair of rails spaced about 7 in. c. to c. and connected by two of the railroad's standard tie-plates, 10¼x7 in., welded to the rail heads. Across each end is an old angle splice bar or a piece of a steel angle, the rails resting on and being welded to the horizontal leg. These angles are of such length as to make a continuous line in the track. The rail fastenings are of the gib and cotter type formerly used extensively in Europe, but with a spring key or cotter instead of a tapering key. The gib or rail clip may be of simple U-shape, engaging the rail base and tie-plate, or it may be made with width varying by offsets so as to fit track rails of varying width. Both of these forms are shown. These ties are being manufactured at the railroad company's shops at the rate of 80 to 90 per eight-hour day, and the company reported that up to November, 1928, about

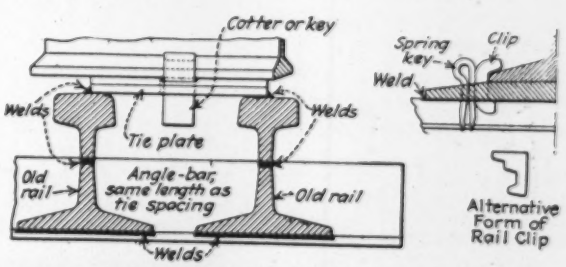


FIG. 13—DALTON TIE OF OLD RAILS, DELAWARE & HUDSON RAILROAD

13,000 had been placed in track. They are used in side tracks principally, with 80-lb. rails and cinder ballast.

Miller Tie—This tie (Fig. 14), used by the Terminal Railroad Association of St. Louis, was designed by Henry Miller, president, and is made at the railroad shops. It consists of two pieces of scrap 100-lb. rail, 8 ft. 3 in. long, bolted together at three points and laid with flanges upward, giving a top width of 10½ in., as against 7 or 8 in. with wood ties. Gas-pipe sleeves are placed on the bolts and the space between the rails is packed with 1:2:4 concrete. An unusual feature in the fastenings is the use of long rail clips, each being about 10 in. long and secured by two bolts. Beveled washers give the bolts a bearing on the inclined faces of the rail flanges. Short clips with single bolts were found insufficient, and this special fastening was devised to provide a more secure grip on the rails. The Miller ties are in main track, but are interspersed with wood ties. Two steel ties are placed at each rail joint and three at intermediate points, so that for each 33-ft. rail there are five steel ties and fourteen wood ties. If used exclusively, fourteen or fifteen of the broad steel ties would give as much rail bearing as nineteen or twenty wood ties. The 100 ties installed in 1924 are reported as in good condition.

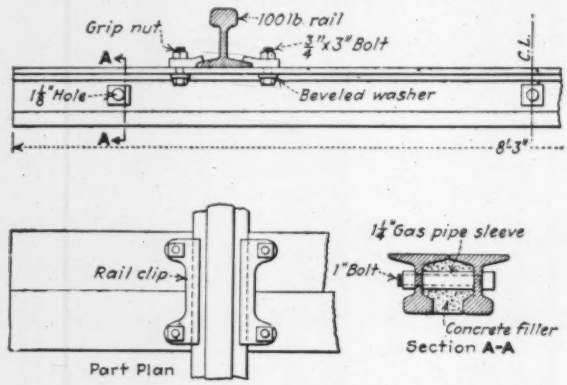


FIG. 14—MILLER TIE OF OLD RAILS, TERMINAL RAILROAD OF ST. LOUIS

Substitute Ties on Foreign Railroads

In some countries substitute ties are used much more extensively than in the United States and are commercial products. But this has only a small bearing on practice here, owing to the different conditions of operation, equipment, climate and management in foreign countries. Steel ties are common in Germany, where the state railways are said to have 40 per cent steel ties and 60 per cent wood ties. But this is owing in part to government requirements for the purpose of fostering the steel industry and restricting the importation of wood, since the country's forests cannot furnish a sufficient supply. For similar reasons the government of Belgium is reported as insisting on the use of steel to a certain extent. Wide use of concrete ties in Italy has been reported, but information is lacking as to the results. In England, steel ties have come into recent prominence, with three of the four trunk railways introducing them, but here also a leading motive is that of rendering assistance to the steel industry in its present depressed condition. Publicity as to these new trials was almost coincident with an address by Sir B. H. Henderson, president of the British Institution of Civil Engineers, in which he said that if prejudice could be overcome and steel ties employed, a safe track would be provided and much needed work provided for the steel manufacturers. On the other hand, although steel has been used extensively in South America, it is reported that the government of Argentina now requires the railways to use native woods, in the interests of the timber industry of the country.

Steel and cast-iron ties are used so extensively in India as to rank with rails, splice bars and structural material as commercial products, while standardization of designs has been recommended by a committee of the government railway board. These conditions result largely from climatic effects and the prevalence of insects which destroy wood very rapidly. Climate is also a factor in the wide use of steel ties in Africa and Australia. In fact, an official report shows that on the South African government railways creosoted native wood ties cost $2.43 and last only twelve to fifteen years; while imported hardwood (untreated) and steel ties cost $1.50 and $1.45, and have a life of 16 to 20 and 30 to 35 years respectively. Broadly speaking, metal ties for domestic, colonial and foreign railways are among the regular products of large foundries and steel mills in Europe.

The Future of Substitute Ties

Returning to the question of the prospects for substitute ties in this country, it is evident from the information and records here given that at present the substitute tie is not a practical issue or a commercial product. Nevertheless there are still these problems: (1) possible reduction in future supply of timber; (2) relative cost and life of wood and other ties; (3) the possibility of making a better and more economical track structure with ties of steel or concrete. These problems should not be left entirely to the consideration of inventors, who are often uninformed as to needs and conditions. It is very desirable, as pointed out in another column, that the subject should receive the thoughtful attention of railroad engineers, since track construction has by no means reached a status beyond which improvement is impracticable.

Conclusions—Three outstanding conclusions may be based upon the foregoing review of the situation: First, there is no immediate demand or necessity for substitutes for wood ties. Second, studies of and experiments with substitute ties should be carried on, with a view to future conditions and to track improvement. Third, such studies and experiments, to be of value, should be on as broad a scale and as scientific a program as those which have been carried out in relation to the preservative treatment of wood ties and which have given such important practical and economic results in railway track construction and maintenance.

Inland Waterways Traffic Increasing

Apparently reflecting the nation-wide awakening of interest in inland waterways, the tonnage through canal channels during the navigation season of 1928 is the largest transported since the canals were enlarged and opened to through traffic in 1918. The merchandise moved amounted to 3,089,998 net tons, an increase of 508,106 net tons, or 19.61 per cent over the season of 1927.

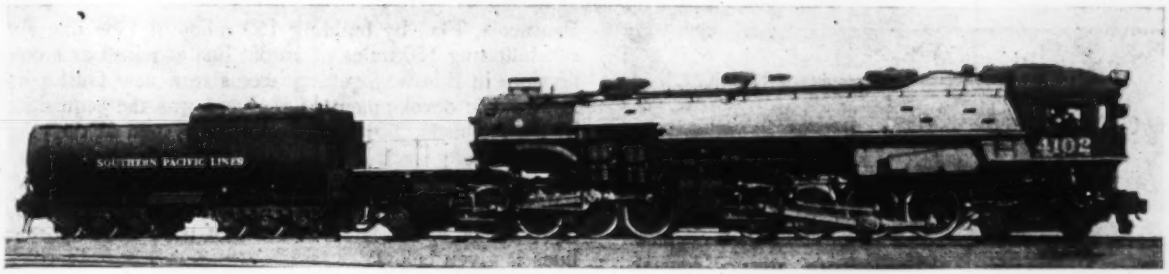


FIG. 1—SOUTHERN PACIFIC LOCOMOTIVE WITH CAB AT FRONT END AND SMOKESTACK AT REAR OF ENGINE

Three New Locomotives of Unusual Size and Design

Powerful Engines of New Type Used by Southern Pacific and Northern Pacific—Odd Design of European Engine

TWO NEW TYPES of powerful locomotives of unusual size have recently been placed in service of the Southern Pacific and Northern Pacific railroads, both roads operating them over heavy mountain grades. In contrast to these long, heavy engines developed in the United States is a European locomotive of odd design using a geared drive and high-speed uniflow type cylinders.

Southern Pacific—A new type of simple expansion articulate locomotive with a 4-8-8-2 wheel arrangement and employing a new design in placing the cab at the front end and the smokestack at the rear end of the engine is now in freight and passenger service on a 139-mile run over the Sierra Nevada Mountains between Roseville, Calif., and Sparks, Nev. A view of this engine is shown in Fig. 1. The locomotives are 120 ft. long over all, 16 ft. 4 in. high, weigh 906,000 lb. and have a tractive effort of 112,760 lb. A steam pressure of 235 lb. is used. Advantage is taken of the fact that they are oil burners to place the cab in the front end with the smokestack at the rear so that the engine cab will be kept free of smoke and gases when operating through tunnels. Ten of the locomotives have been placed in service at a cost of $1,400,000.

Northern Pacific—A simple Mallet 2-8-8-4 locomotive 125 ft. long and weighing 1,116,000 lb. has been placed in freight service between Glendive, Mont., and Mandan, N. D., operating over a division of undulating profile with ruling grades of 1 per cent so distributed over the territory that the establishment of helper districts is impracticable. Figs. 2 and 3 show side and front views of this engine. It has a tractive effort of 140,000 lb., with an additional 13,000 lb. supplied by a trailing booster. Steam pressure at 250 lb. is generated by one of the largest boilers ever used in a locomotive, 63 ft. 8¾ in. long. Features of design in the new engine include an air-operated throttle; the use of superheated steam on stoker engine, headlight dynamo, booster, blower, air pumps and whistle; outside bearing engine truck; ball-joint steam pipe connections replacing slip-joint connections and a pressure gun system of lubrication. The

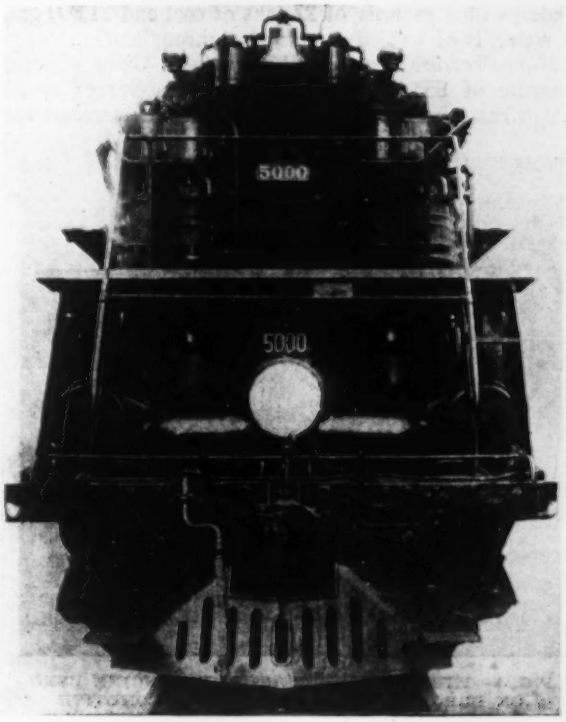


FIG. 3—FRONT VIEW OF NEW NORTHERN PACIFIC ENGINE

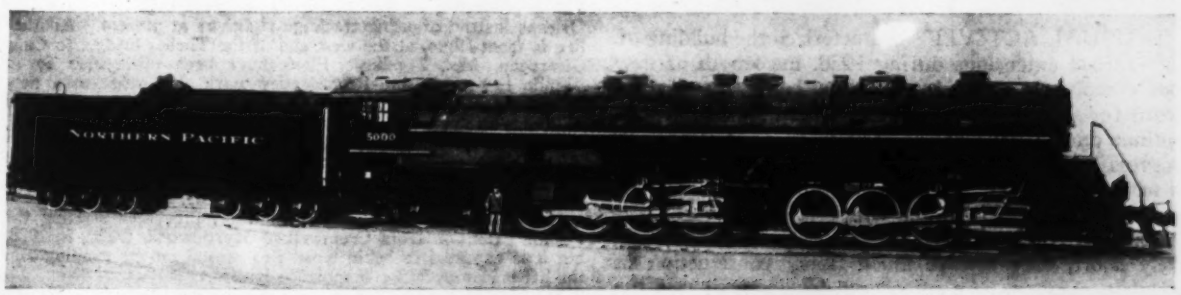


FIG. 2—POWERFUL FREIGHT LOCOMOTIVE USED ON NORTHERN PACIFIC

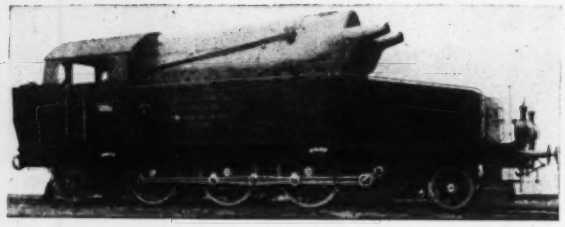


FIG. 4—EUROPEAN LOCOMOTIVE USING STEAM PRESSURE AT 853 LB. IN THREE-CYLINDER UNIFLOW ENGINE

tender, with a capacity of 27 tons of coal and 21,200 gal. of water, is of welded construction throughout.

High-Pressure European Locomotive—Using a steam pressure of 853 lb. per sq.in., a locomotive of novel design has been developed in Europe. The unusual appearance of this engine is shown in Figs. 4 and 5. Power is supplied by a three-cylinder uniflow engine mounted on top of the front end of the frame. Steam is admitted to the cylinders through 2-in. disk valves at each end and exhausts through ports at the center uncovered by the piston. The uniflow engines are gear connected to a main drive shaft located at the front of the drivers. Feed water is preheated to 510 deg. F. All cranks are balanced and all working parts are fitted with pressure lubrication.

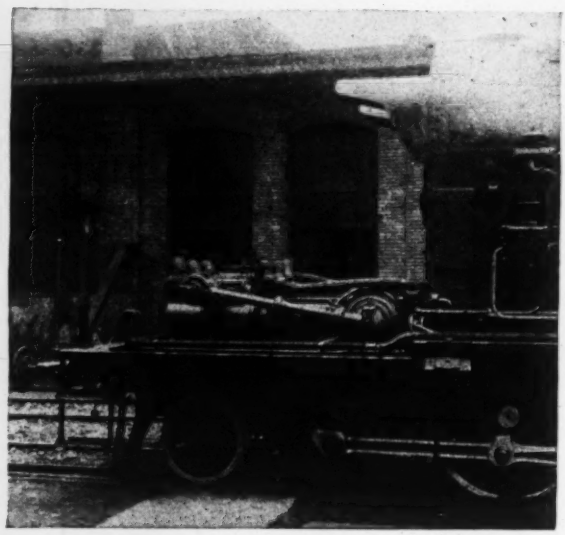


FIG. 5—THREE-CYLINDER UNIFLOW ENGINE USED ON EUROPEAN HIGH PRESSURE LOCOMOTIVE

Railroad Construction, 1928-29

UNUSUAL ACTIVITY characterized the building of railroad extensions during 1928, the length of new lines completed, about 1,025 miles, being the highest record for several years. This condition seems likely to continue during 1929, as considerable work is already in progress. Much of this activity was in Texas, to open up new districts, but a notable feature is the amount of work being done in Virginia and West Virginia to link up existing lines. Although these extensions are relatively short, they involve much heavy construction in mountain country. An important development was the entrance of the St. Louis-San Francisco Railway into Pensacola, Fla., by building 150 miles of new line and rehabilitating 150 miles of an old line acquired as a connection, in this way getting access to a new Gulf port. A strategic development of the year was the acquisition by the Atchison, Topeka & Santa Fe System of the large but financially weak Kansas City, Orient & Mexico Railway, adding about 820 miles in this country and 630 miles in Mexico to the 12,400 miles of the Santa Fe System. A brief review of some of the more important lines is given below:

Texas and the Southwest

Atchison, Topeka & Santa Fe—About 75 per cent of the work is done from Pampa, Tex., to Cheyenne, Okla., 85 miles, to connect the isolated Cheyenne-Clinton line with the main system. This year it will build from Lane City to Guy, Tex., 18 miles. Of other lines proposed none is yet under construction.

Colorado & Southern—Two extensions in the South Plains district by the Fort Worth & Denver City Railway are completed: Estelline to Dimmit, 130 miles, and Silverton to Lubbock, Tex., 160 miles.

Texas & Pacific—Its subsidiary the Texas & New Mexico Railway is building from Monahans, Tex., to the New Mexico state line, 35 miles, and has applied for a permit to extend to Lovington, N. M., 65 miles.

Waco, Beaumont, Trinity & Sabine—Two 100-mile lines are projected: Livingston to Port Arthur and Waco to Weldon.

Rock Island Lines—On the new 154-mile line from Amarillo, Tex., to Liberal, Kan., track is laid for 93 miles and grading is in progress on the 61 miles into Liberal. Work has not been started on the 7-mile cutoff around Oklahoma City or on the 80-mile line from Coburn to Birmingham, Mo.

Beaver, Meade & Englewood—An extension west from Hooker to Hough, Okla., 20 miles, is nearly completed, and the company has until December, 1930, to continue to Des Moines, N. M., to connect with the Santa Fe System.

Quanah, Acme & Pacific—This subsidiary of the Frisco Lines has completed its 28-mile extension to Floydada, Tex., connecting with the Santa Fe, and has plans for a further extension to El Paso.

West and Northwest

Great Northern—The 7.8-mile Cascade tunnel is completed, with 20 miles of relocation on the east approach. The new line from Saco to Hogeland, Mont., was put into operation Dec. 1.

Southern Pacific—The line from Klamath Falls to Alturas, Calif., 95½ miles, is under contract, with about 10 per cent completed but no track laid up to Feb. 1. It will give a new route from Oregon and Washington points to the Southwest and a short route to Eastern points.

Denver & Salt Lake—Preliminaries are still in progress for the proposed 42-mile Orestod-Dotsero line, to connect with the Denver & Rio Grande Western and give the latter a shorter route to Denver by way of the Moffat tunnel.

San Luis Valley Southern—Permit has been asked for a 22-mile extension south from Jarosa, Colo., to Questa, N. M.

Mound City & Eastern—This new independent line is to extend from Leola, S. D., on the Minneapolis & St. Louis Railway, due west to Mound City, 66 miles. It has about 36 miles graded and 3 miles of track laid from Leola, and is expected to be completed next fall.

Southern

Kansas City Southern—The new line between Leeds and Grandview, Mo., 13¾ miles, to give the road its own entrance to Kansas City, is expected to be completed by October, 1929.

Missouri Pacific—A line from Baton Rouge to New Orleans, La., is projected, so that this road will have own line into New Orleans instead of using trackage rights as at present. Another line is from Illmo, at the west end of the Thebes bridge, to Cape Girardeau, Mo., 7 miles. Plans have been made also for a 20-mile low-grade line from Valley Park, Mo., east to a new Mississippi River bridge below St. Louis, giving a bypass around St. Louis to the terminals on the east side of the river.

St. Louis Southwestern—By means of two new lines connecting existing railroads a more direct route from St. Louis to Memphis is proposed. These would be from Gideon to Deering, Mo., 20 miles, and Hornersville to Leachville, 10 miles.

Meridian & Bigbee River—High water prevented starting the 21-mile extension from Cromwell to Myrtlewood, Okla., in 1928, but it is expected to begin work this season on the grading and the lift bridge over the Tombigbee River.

Florida East Coast—A 9½-mile line from Belleglade-Choser to Lake Harbor is under construction.

St. Louis-San Francisco—Access to the Gulf port of Pensacola, Fla., was effected by building 150 miles from Aberdeen, Miss., to Kimbrough, Ala., and rehabilitating 150 miles of the old Muscle Shoals, Birmingham & Pensacola Railway from Kimbrough to the coast.

EAST AND SOUTHEAST

Louisville & Nashville—Work is approximately half completed on the difficult 14-mile line through the mountains south from Hagans, Va., to Chevrolet, to connect with the Clinchfield Railroad and thus with the Atlantic Coast Line as an outlet to South Atlantic ports. About 3½ miles are being built by company force and 10½ miles by contract.

New York Central—The Ohio Central Lines expect to have contracts let and work started this spring on the 30-mile extension from Swiss, W. Va., to connect with the Chesapeake & Ohio at Nallen.

Norfolk & Western—Two lines are under construction: the Big Sandy & Cumberland, 40 miles, to be completed by the end of 1930; the Guyandot & Tug River, from Wharncliffe to Gilbert, W. Va., 10½ miles, to be completed in 1931.

Virginian—Its subsidiary, the Virginian & Western, has contracts let for 33 miles of the 42-mile line from Itman to Gilbert, W. Va. This line follows the Guyandot River through mountainous country, with heavy rock work, ten steel bridges and seven tunnels.

Georgia & Florida—An extension north from Augusta, Ga., to Greenwood, S. C., 55 miles, is proposed.

Pittsburgh & West Virginia—A contract has been placed for 10 miles of the 40-mile extension to Connellsville, Pa.

Detroit, Toledo & Ironton—Work is more than 75 per cent completed on the 45-mile cutoff from Malinta, Ohio, north to Petersburg, Mich., to give a direct line to Detroit, with a saving of about 20 miles in distance. From Petersburg northward, 10 miles have been completed to Durban Junction.

Status of the Pan-American Railway

RAILWAY development in Central and South America is gradually linking up the several countries and connecting Central America, at least, with the United States, although there is not at present any concerted movement for the completion of the project for the Pan-American Railway, to afford rail communication from the United States to Buenos Aires, Argentina. The present situation, as summarized in the accompanying table, is that in the total distance of 10,116 miles there is 7,126 miles of line completed, leaving 2,990 miles yet to be built, mainly in the northwestern portion of South America, where both topographical and traffic conditions are unfavorable. These figures are furnished by the Pan American Union, at Washington. Not all of the connecting lines have the same gage, therefore some transshipment would be necessary even with a continuous line of railway.

Already there is continuous rail connection from the railway system of the United States through Mexico, Guatemala and Salvador to La Unions and Cucuta, on the Pacific coast of Salvador (see *Engineering News-Record*, March 20, 1927, p. 474). The gap of 430 miles from Cucuta through Honduras, Nicaragua and Costa Rica to the Panama Canal Zone is expected to be closed in 1933 by the linking up of existing lines. In South America the extension of the Bolivian government railways southward to connect with the railway system of Argentina (see *Engineering News-Record*, Aug. 31, 1922, p. 352) has completed a continuous rail route from Guaqui, Bolivia (on Lake Titicaca), to Buenos Aires, about 1,600 miles.

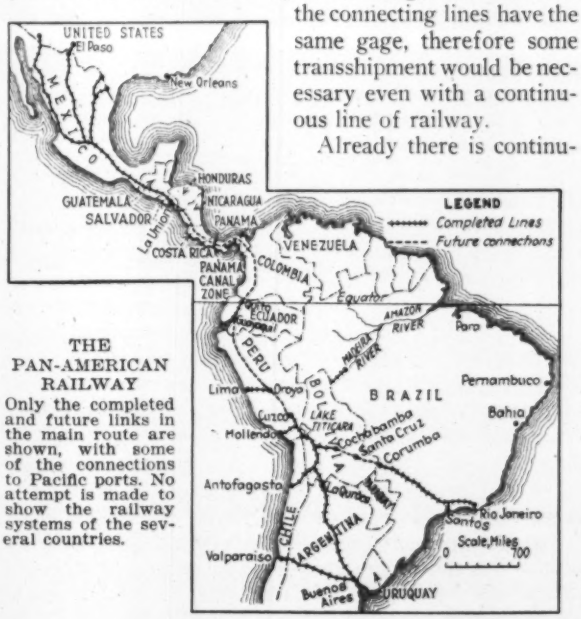
The longest stretches of line yet to be built are those through Colombia, Ecuador and Peru. They are in very difficult mountainous country and their construction is not even definitely planned. In the meantime, however, this link may be closed effectively by coast navigation touching ports which are connected with the existing sections of the Pan-American railway. In the original project this part of the route, as laid out by the Intercontinental Railway Commission in 1890, ran on the steep west slope of the Andes. At the sixth International Conference of American States, held at Havana, Cuba, in January, 1928, the Pan-American railway committee made a report recommending that this route be changed to lie along the east slope of the Andes, where the topography is more favorable and where connection could be made with ports at the head of inland navigation reaching the Atlantic Ocean. The location shown on the accompanying map is that of the original project on the western slope of the Andes Mountains.

After careful consideration, however, the conference reached the conclusion that the original route should be maintained. It suggested also that the commission on the Pan-American railway, at Washington, should study the alternative locations proposed with a view to future complementary lines, but not as substitutes for the main or original location. That conference also passed a resolution urging the several South American states to construct or complete the portions of the railway within their borders, as an "expression of the spirit of continental fraternity."

An important subsidiary of the main north-and-south route is a lateral line eastward through Bolivia and Brazil to Rio de Janeiro. The Bolivian government has taken steps to extend an existing line from its present terminus at Cochabamba to Santa Cruz, 385 miles, but the date of its completion is indefinite. From Santa Cruz there will be a further stretch of 425 miles to Puerto Suarez, on the Paraguay River, which is the national boundary. From the Brazilian port of Corumba, on the opposite side of the river, there is an existing railway to Rio de Janeiro, about 1,100 miles. While such a line would be of great political and commercial value, it is evident that the closing of the 810-mile gap is a matter of a rather remote future.

PAN-AMERICAN RAILWAY IN 1929

	Built, Miles	To Be Built, Miles
New York to Guatemala	3,869	....
Guatemala to Panama Canal Zone	753	430
Panama Canal Zone to Puno, Peru	802	2,560
Puno to Guaqui, Bolivia (lake transport)	102	....
Guaqui to LaQuiaca, Argentina	540	....
LaQuiaca to Buenos Aires	1,060	....
Total	7,126	2,990



THE PAN-AMERICAN RAILWAY

Only the completed and future links in the main route are shown, with some of the connections to Pacific ports. No attempt is made to show the railway systems of the several countries.

Contracting Problems Reviewed at A. G. C. Convention

Largely Attended Meeting in Chicago Considers Important Reports on Credit Reform, Accident Prevention, Prequalification of Bidders and Some Twoscore Other Subjects Assigned to Standing and Special Committees

MATERIAL progress in association work by contractors was shown by the proceedings of the annual convention of the Associated General Contractors held in Chicago Feb. 18 to 21. In a sense the convention also was a celebration of the first decade of life of national association work. Reminisence and review, however, were in the main subordinated to the business in hand of advancing committee activities in credit reform, accident prevention, prequalification of bidders, development of affiliated bureaus and revision of bylaws and rules of procedure. These developments chiefly will be reviewed here. As a variation from committee reports and discussions papers were read on prequalification of bidders by H. S. Sisson, former New York state highway commissioner; on constructing improvements on the Mississippi River by Gen. T. H. Jackson, president Mississippi River Commission, and on the engineer's view of the contractor by Anson Marston, president of the American Society of Civil Engineers.

Committee Reports

In the main the association work is performed by a staff of office and field men in co-operation with standing committees. Since these activities were reported to the convention at several sessions and as they were ready for presentation, they are given here without attempt to follow their actual order in the convention proceedings.

Equipment Depreciation—During the year on invitation of the Bureau of Internal Revenue a committee has formulated specific recommendations which are to form the basis of an agreement between the bureau and the contracting industry for figuring depreciation allowances. Five permissible methods of accounting depreciation and a schedule of useful life of various machines were agreed upon. These methods and rates will be made standard among the several thousand checkers in the income tax unit.

Contract Bonding—As the result of nearly ten years' work by a committee on contract bonding reform there was organized an affiliated bureau of surety companies which will develop a program for improving surety bonding practices. At present eighteen surety companies have become members of the bureau. They write probably 75 per cent of all the business. In presenting its report the committee pointed out that this is a definite step to correct a condition which has done much to encourage a dishonest and irresponsible element in contracting.

Equipment Rental—A new rental schedule for construction equipment, giving rental rates in dollars and cents as well as in percentages of the capital investment, is well on the way to completion. It was to have been presented at the present convention but had been held up pending an agreement with the Bureau of Internal Revenue on depreciation, previously mentioned. The new schedule will probably state two sets of rates—one representing the contractor's bare cost of ownership and maintenance without profit, and the other including the gross margin necessary for the renting of equipment as a business. The latter rates are to be determined after conference and exchange of information with equipment distributors and renting companies.

Accident Prevention—A great portion of the contracting industry is still asleep on accident prevention and apparently does not realize that every man killed or injured brings nearer the enactment of drastic safety legislation which cannot better the situation but which will certainly hamstring the business of contracting. The humanitarian and the money-saving aspects of safety work have stirred many member companies of the association to action, but not enough. These two aspects, plus the specter of unsound legislation and all of its abuses, are believed to warrant all of the effort that the national staff has devoted in the past two years to accident prevention. The association members should be on constant guard against efforts being made to misinterpret their stand on accident prevention. The A.G.C. is exerting every means at its command to reduce accidents, but it knows from bitter experience that the principal improvement can come only through education of the working force. This cannot be done by inflexible detailed codes, which penalize the contractor for the ignorance, carelessness or maliciousness of a workman.

Qualifying Bidders—Requiring bidders to demonstrate their responsibility before obtaining a contract is one phase of the general attack on irresponsibility, loose credit and overexpansion in the contracting industry. The subject is being pushed principally in the public field, as that field is most sorely in need of the process. The initial step taken in 1925 was the proposition of the joint conference on construction practices, which developed the standard bidders' questionnaires. They are now being used by 30 state highway departments using questionnaires (Louisiana advises intention to do so as this report is written) also by the Bureau of Public Roads and on occasion by U. S. Corps of Engineers, which has just sent copies to all its district and division engineers. About twenty cities in the East are using the forms, and they are approved as standard by the American Association of State Highway Officials.

Day-labor Construction—Day-labor operations of federal bureaus have been practically eliminated except in the U. S. Corps of Engineers. A few projects of questionable suitability for contracting have been done by day labor outside the corps, but they have been of little importance.

Cards were stacked against contractors on levee bidding last year when the corps bid on certain work and added 1½c. per cubic yard to the contractor's bid in comparing its own costs with the prices of other bidders. After a protracted controversy, which brought the president and some of the staff of the A.G.C. to Memphis and along the Mississippi River, the award was made to contractors.

Several conferences have been held with the Chief of Engineers or his assistants and assurance has been given that the corps favors contract work. It has expressed the intention of doing only sufficient day-labor work to keep a check on costs, handle emergencies and perform projects which contractors do not want. The word of the Chief of Engineers is accepted at face value, but the desire of various district engineers to force contractors out of the field is unquestionable, and we may expect the necessity of continuing opposition for some time to come. This day-labor work is not merely the affair of river and harbor contractors but is an unwarranted violation of principle, which the entire industry should resist. At a later day it may not be the levee contractor or the dam builder who is most concerned.

The national office is keeping a record of equipment purchase by the government bureaus and will unquestionably present the facts to the proper committees of Congress if the need arises.

Quantity Survey—Considerable time and traveling were expended during 1928 to encourage the formation of quantity survey bureaus by local A.G.C. units. There is no longer any argument as to whether the use of quantity surveys will spread in this country as in Europe. It is spreading rapidly. The matter now for consideration is whether such bureaus should be owned or controlled by A.G.C. chapters or be left to independent development.

Abuses such as supplying inexperienced persons with bid prices, production of poor surveys and promiscuous distribution of such surveys are already too pronounced to be ignored. The national staff has found it necessary in a number of cases to warn members against irresponsible or fraudulent actions of specific bureaus. On two occasions it has been requested to recover money collected from members under false pretenses. It appears certain that competition in the operation of survey bureaus will bring untold grief to the contracting industry.

Bureaus are now operated by the Texas and Carolina branches, and by the chapters of Birmingham, Detroit, Hartford, Memphis, Milwaukee, Philadelphia, Portland and St. Louis. Other chapters are preparing to take up this activity.

Separate Contracts—An analysis of separate contracts, as opposed to the general contract system, was prepared during the past year by a member of the staff and has been widely used by contractors throughout the country in presenting their views to architects and owners. This analysis was presented before a meeting of the American Society of Civil Engineers in New York, was published in the society's *Proceedings* and has lately been accepted for publication in the society's *Transactions*. It is available from the Washington office in pamphlet form.

An attempt of certain trades to have the interdepartmental board of contracts and adjustments approve separate contracts as a policy for the government was counteracted after presentation of a brief and a hearing before the board. Lately the Treasury Department has decided to discontinue the use of separate contracts. A similar decision was thought to have been obtained from the Veterans' Bureau about a year ago, but has not been complied with. Activities along this line are to be continued.

It may as well be recognized by the membership that in dealing with this subject the staff is conducting an activity that is sound in principle but difficult to handle because of existing practices among contractors. The evidence presented by subcontractors is all too conclusive that their proposals are "peddled," that their money is used to finance general contractors in a manner that is entirely improper and that they are not paid according to their agreement in many cases. Many subcontractors will admit that the separate contracts system is not sound, but they prefer an unsound system to one in which they cannot generally obtain a fair deal.

The fact that many members of the association are not guilty of these practices does not serve as a deterrent to the subcontractor organization seeking separate contracts. Those organizations in all probability will continue to make progress among individual architects, public officials and state legislatures, unless the situation as a whole in the general contracting group is improved.

Mixer Bureau—Membership in the mixer bureau of the A.G.C. now represents 100 per cent of the paver production and 97 per cent of the production of building mixers. It has sixteen members, who last year produced 12,000 mixers.

The bureau has its own technical committee, which is constantly improving the technique of mixer manufacture. The standards of the bureau, which are known as A.G.C. Standards, are incorporated into the specifications of seven state highway departments and are observed through departmental order by many others. Through the functioning of this bureau, the annual obsolescence of a great amount of mixing and material hauling equipment has been eliminated. Also a reduction of 7 per cent has been accomplished in production costs which has been passed along to the construction industry.

Finances—The income of the association for 1928 was $141,755.38; the expenditures were $128,582.98. The difference between income and the expenditures, $13,172.40, was applied against the deficit of the association accumulated since its inception and which is now reduced to $4,618.56. The sum of $5,000 has been used to retire the organization's bonds.

The accounting system of the association has been completely reorganized and the association is in the best condition of its history.

Changes in Bylaws Tabled

To meet the evident need for a new financial set-up if the association is to develop progressively the committee on constitution suggested changes in bylaws as follows:

BYLAWS—ARTICLE III

Section 2—In addition to the $55 mentioned in Section 1, the annual dues of members at large shall be as follows:

(Class A) Members at large whose average gross business per year in the preceding three years was less than $250,000 shall be $50.

(Class B) Members at large whose average gross business per year in the preceding three years was more than $250,000 but less than $2,500,000 shall be $250.

(Class C) Members at large whose average gross business per year in the preceding three years was more than $2,500,000 and less than $5,000,000 shall be $500.

(Class D) Members at large whose average gross business per year in the preceding three years was more than $5,000,000 and less than $10,000,000 shall be $750.

(Class E) Members at large whose average gross business per year in the preceding years was over $10,000,000 shall be $1,000.

BYLAWS—ARTICLE IV

Section 5—Members at large are required to join the branch or chapter having jurisdiction over the territory where they have their home office. Except in the territory under the jurisdiction of such branch or chapter as they may join, they are only entitled to the privileges extended by the national association. Provided, that if an applicant for member at large has some good reason for not joining the local branch or chapter the membership committee can at its discretion allow such applicant to have membership at large after joining some other branch or chapter.

Section 11—If a difference of opinion exists between the members of a branch or chapter and any member of another associ-

ated organization, working in the territory of first-mentioned branch or chapter, that cannot be mutually adjusted, an appeal may be taken by either party to the membership committee. Said committee shall hear both sides and use its good offices to adjust the difference.

Considered in executive session these changes after active discussion were denied by tabling the report and ordering the reorganization of the committee and the submission of a revised report at the next annual convention.

Election of Officers

The following officers were elected: president, T. T. Flagler, president T. T. Flagler Company, Atlanta Ga.; vice-president at large, H. S. Tullock, president Missouri Valley Bridge & Iron Company, Leavenworth, Kan.; vice-presidents (Zone 2), Harry H. Wilson, Winston Brothers Company, and H. H. Wilson, Harrisburg, Pa.; vice-presidents (Zone 4), R. L. Goode, president Goode Construction Company, Charlotte, N. C., and W. T. Hadlow, Jacksonville, Fla.; vice-president (Zone 5), J. T. Haile, Jr., president L. T. Wright Company, San Antonio, Tex.; director (District 1), T. J. Purdy, president T. J. Pardy Construction Company, Bridgeport, Conn., and A. W. Merchant, president A. W. Merchant, Inc., Providence, R. I.; director (Districts 2-3), William V. McMenimen, vice-president Raymond Concrete Pile Company, New York, N. Y.; director (District 10), D. A. Daly, Foley Brothers, Inc., St. Paul, Minn.; director (Districts 12-13), Herman Brown, Brown & Root, Austin, Tex.; director (Districts 14-15), Henry J. Kaiser, president Kaiser Paving Company, Oakland, Calif.; director (District 16), W. H. Fiegenson, president Lindstrom & Fiegenson, Portland, Ore.

Winter Construction Costs Itemized on a Concrete Building

Winter Protection From January to April Inclusive Added Less Than 1½ Cents Per Square Foot of Floor Area

By B. R. Gebhart

Manager, General Educational Bureau, Portland Cement Association, Chicago, Ill.

THE expounded theories of winter construction are forcibly exemplified in the carefully compiled cost figure on a nine-story, reinforced-concrete frame apartment building erected in Detroit during the winter of 1928 by the Butts Construction Company, Detroit, Mich.

This building contained 1,394,300 cu.ft. It required 220,283 sq.ft. of form and contained 123,740 sq.ft. of floor area, not including the roof slab. Allowing the same area for the roof as for each floor gives a total of 137,490 sq.ft. of slab to be protected.

The placement of concrete began on Jan. 31, 1928. By Feb. 29, 11,687 cu.ft. of foundation, 11,193 cu.ft. of walls and 1,605 cu.ft. of structural frame, a total of 24,485 cu.ft., had been placed. In that 30-day period 30,500 lb. of coke had been used for heating purposes, at a cost of $158.64. Labor amounted to $451.18, giving a cost of 2.5c. per cubic foot.

Up to April 4, 61,270 cu.ft. of concrete had been placed, at a cost for cold-weather precautions of $1,227.95, or 2.2c. per cubic foot.

With structural work completed May 4, 81,766 cu.ft. of concrete had been placed and 93,770 lb. of coke had been used, costing $488.11. Labor amounted to $1,029.45, making a total cost of $1,517.56. About 1.15 lb. of coke per cubic foot had been used, at a cost of 0.6c. Labor amounted to 1.3c. per cubic foot, giving a total cost per cubic foot of 1.9c.

Labor as expressed above represents the amount of money spent in placing and firing salamanders, handling coke and placing and removing tarpaulins, but does not include the purchase or rental of canvas or tarpaulins.

The cost per cubic yard of mass concrete plus cold-weather protection amounted to $10, while structural concrete plus protection showed a cost of $14 per cubic yard.

If we allow $30 for the use of salamanders and $200 as interest and depreciation on canvas, we have a total cost of cold-weather protection on concrete of $1,747.56. With 137,490 sq.ft. of floor slab to be protected, this amountes to 1.3c. per square foot of floor area.

Formwork, according to the experience of the Butts Construction Company, does not cost any more in cold weather than in warm weather. Brisk cold weather is invigorating, and although the carpenters are forced to wear more clothes, they work harder and actually accomplish much more than on a hot, sultry day. As for steel placing, costs are the same in cold or warm weather.

On the other hand, if the structural work of the building had been carried on during the summer to escape the cost of precautionary measures against the freezing of concrete and the finishing and decorating had been done during the winter months, necessitating a temporary heating system, the additional costs would have been considerably greater.

The accompanying table of progress and costs was compiled by the Butts Construction Company.

COST OF COLD-WEATHER PROTECTION ON A NINE-STORY REINFORCED-CONCRETE BUILDING

Period	Amount of Concrete, Cu.Ft.	Fuel: Weight, Lb.	Fuel: Cost	Labor Protective	Labor Plus Coke	Fuel Lb. Per Cu.Ft.	Cost Fuel Per Cu.Ft.	Labor Per Cu.Ft.	Total Cost Per Cu.Ft.
Jan. 31-Feb. 29	Found. 11,687								
	Walls 11,193								
	Struc. 1,605								
	Total 24,485	30,500	$158.64	$451.18	$609.82	1.25	$0.007	$0.018	$0.025
Feb. 29—March 14	Struc. 3,494	8,000	41.00	86.04	127.04	2.29	0.012	0.025	0.037
Cumulative	27,979	38,500	199.64	537.22	736.86	1.38	0.007	0.019	0.026
March 14-21	6,402	12,000	80.00	113.45	193.45	1.87	0.012	0.018	0.030
Cumulative	34,381	50,500	279.64	650.67	930.31	1.47	0.008	0.019	0.027
March 21-28	7,911	4,000	20.00	74.00	94.00	0.51	0.003	0.009	0.012
Cumulative	42,292	54,500	299.64	724.67	1,024.31	1.29	0.007	0.017	0.024
March 28-April 4	8,100	19,100	95.50	108.14	203.64	2.36	0.012	0.013	0.025
Cumulative	50,392	73,600	395.14	832.81	1,227.95	1.46	0.008	0.017	0.025
April 4-11	10,878			71.17	71.17			0.007	0.007
Cumulative	61,270	73,600	395.14	903.98	1,229.12	1.20	0.007	0.015	0.022
April 11-18	8,187	12,600	58.90	69.30	128.20	1.54	0.007	0.009	0.016
Cumulative	69,457	86,200	454.04	973.28	1,427.32	1.23	0.007	0.014	0.021
April 18-25	6,230			47.77	47.77			0.008	0.008
Cumulative	75,687	86,200	454.04	1,021.05	1,475.09	1.14	0.006	0.014	0.020
April 25-May 2	6,079	7,570	34.07	8.40	42.47	1.25	0.006	0.001	0.007
Cumulative	81,766	93,770	488.11	1,029.45	1,517.56	1.15	1.006	1.013	0.019

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Handling Penstock Pipe on Buck's Creek Project

By Daniel McFarland
Storrie, Calif.

A SPECIAL derrick and interesting method were used to handle the 9,600 ft. of pipe in the two penstocks on the Buck's Creek project of the Feather River Power Company at Storrie, Plumas County, Calif. The penstock has a static head of 2,570 ft. and the pipe varies from 3 to 4½ ft. in diameter.

Previously to excavating the trench for the pipe a double tram line was built up the mountain side, following the surface of the existing ground without much cutting or filling. Since the pipe was on a uniform grade between anchors, the tram line was consequently at a variable height above the trench. A derrick was therefore required for unloading and placing the pipe. The derrick, as may be seen in the accompanying illustrations, consisted of a heavy set of skids resting on the concrete piers and an A-frame hinged at the bottom so that it could be adjusted to the varying slopes of the penstock. The mast was pivoted between the legs of the A frame and the boom attached to the mast. Fig. 1 shows the method of handling the pipe. By means of a wire rope sling and differential pulleys on the boom line, the pipe was lifted from the car, at the same time being held from sliding down hill by a line connected to the hoist. Two pipes were set in position, then the derrick pulled itself up the hill a pipe length, and two more were placed. The pipe was furnished and placed by the Western Pipe & Steel Company, of San Francisco, and the Ferrum Company, of Poland.

FIG. 1—LIFTING A PENSTOCK PIPE FROM TRAM CAR

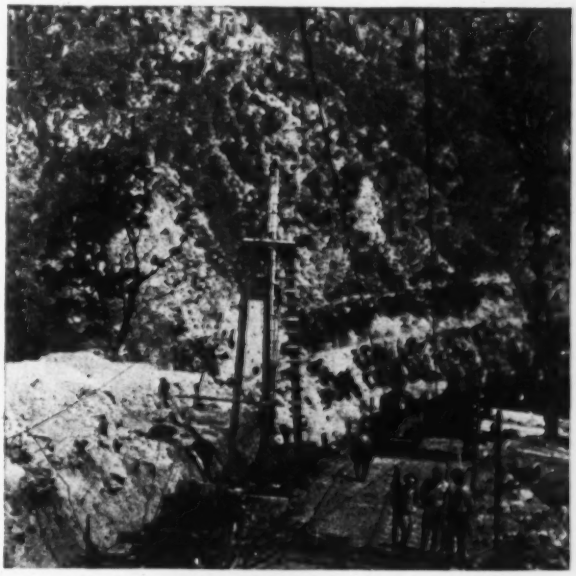


FIG. 2—PLACING PENSTOCK PIPE ON BUCK'S CREEK HYDRO-ELECTRIC PROJECT

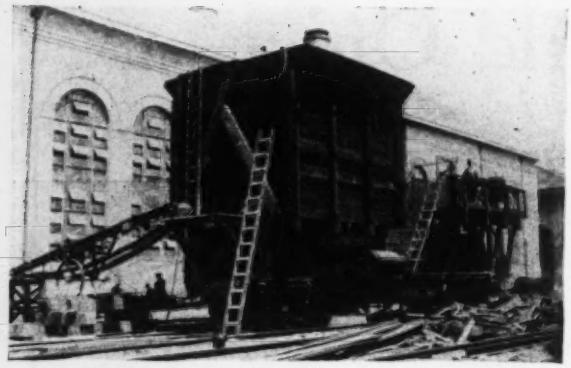
Double tram line brought pipe from bottom of mountain and special derrick with hinged bottom adjustable for the varying slope of the penstock was used to place the pipe.

Mobile and Movable Mixing Plants for Scattered Operations

By T. Farrance Davey
Long Beach, Calif.

THE two concreting outfits shown by the drawings, one mounted on a railway car and the other built in portable units, were employed in constructing a large Western power plant. While the main structure was concreted by a tower and chutes, the extended nature of the rest of the work, comprising many isolated foundations for transmission towers, switch apparatus, cable tunnels, circulating water tunnels, pump houses and other structures, necessitated the employment of a more flexible source of concrete supply. This was obtained by designing and building the movable and mobile mixing plants illustrated.

The movable mixer, including a 40-cu.yd. wooden bin for gravel and a 28-cu.yd. bin for sand supplying a ¾-yd. mixer, was especially suitable for pours of considerable magnitude, being fed with material by a locomotive crane from cars on sidings laid alongside. The chutes and hopper gates were air operated. Cement was



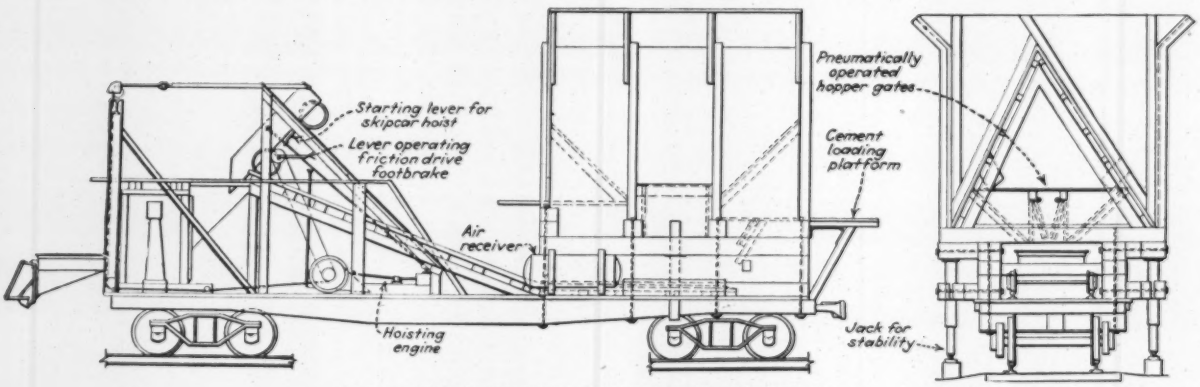
MOBILE MIXING PLANT MOUNTED ON FLAT CAR

supplied by gravity conveyors from the railroad cars, and the mixer itself was electrically driven.

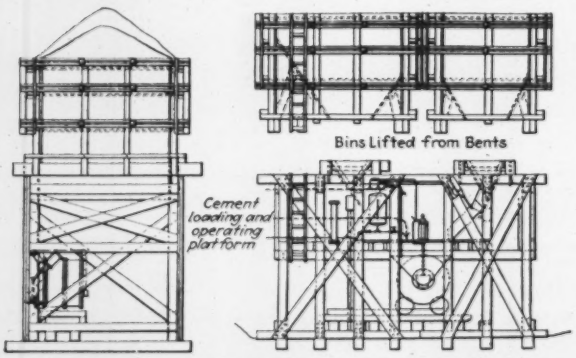
The bins and supporting bents were made in 5-ton pieces for ease of transportation and the mixer traveled a number of miles both by rail and by barge during the progress of the job. It was finally equipped with a tower hoist and provided the concrete for a two-story electrical control house.

The mobile mixer was built on a second-hand flat car and ballasted with 20 tons of steel punchings. The bins had a storage capacity of 25 cu.yd. of gravel and 17 cu.yd. of sand supplied to a ¾-yd. mixer by a skip car running on an incline and driven by an air-operated hoist. A second-hand engine provided motive power for the mixing machine and an elevator supplied cement to the charging platform. All equipment, chutes and hopper gates were pneumatically operated. An operating platform level with the top of the mixer gave a view of all operations and was provided with controls for all of the equipment.

The whole site was served with compressed air for the operation of tools and equipment, air being considered a safer medium of power than any other, so that no difficulty was experienced in obtaining motive power.



CAR-MOUNTED MIXING PLANT OPERATED BY AIR



MIXING PLANT BUILT IN 5-TON UNITS FOR PORTABILITY

From Job and Office

Hints That Cut Cost and Time

Reversible Templet for Changing Subgrade Profiles

By C. J. Dunston

Division Engineer, State Highway Department, Greenville, S. C.

A UNIQUE type of subgrade templet is being used on a 22-mile concrete pavement between Greenville, S. C., and Princeton, S. C. Claussen & Lawrence, of Augusta, Ga., are the contractors and J. S. Heiss is resident engineer.

Two standard sections of pavement are being used. Where the project follows closely the alignment of the old topsoil-surfaced road or in cuts with firm subgrade, the section used is 7½-6-7½ in. On new locations or where subgrade conditions are not good an 8-6½-8 in. section is used. During the course of a day's work it is necessary to change several times from one section to the other.

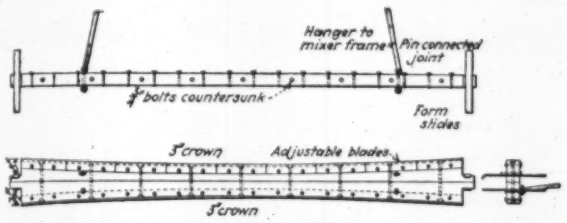
It was found that considerable time was lost in changing templets where a separate templet was used for each standard section, or to make the necessary adjustment where only one templet was used. To avoid these delays the contractor constructed a reversible templet that could be changed in a short time by pulling the pins out of the eyebolts on the side of the templet, turning it over and replacing the pins through the eyebolts on the reverse side. The rods pulling the templet are bolted to the mixer frame near the front of the mixer.

The templet is constructed of two 6x10-in. timbers bolted together with ¾-in. bolts spaced 2 ft. apart, the heads and nuts being countersunk. Sharp-edged steel plates 2 ft. in length are bolted to each templet as a cutting edge. These plates are adjustable to care for any sag in the timber.

This templet is not entirely depended upon to establish

From Job and Office

For Contractor and Engineer



REVERSIBLE TEMPLET CHECKS TWO SUBGRADE PROFILES

the fine grade after the forms are set. A subgrade tester, commonly called a scratch templet, with a clean-up blade in front, is used ahead of the mixer. A light hand-pulled templet is used as a final check behind the reversible subgrade templet.

Maximum Stresses in Guy Ropes and Derrick Stiff-legs

By T. Farrance Davey
Long Beach, Calif.

IN COMPUTING the stresses in guy cables on derricks or tall structures, and in derrick stiff-legs, the usual course is to assume the effect of the hoisting or wind load to be a maximum when its direction lies in the vertical plane passing through that guy or stiff-leg. This assumption is correct only for guys spaced 90 deg. or less apart, in installations using four or more guys. When only three are used the stress in one guy becomes a maximum when the load is applied at 90 deg. to either of the adjacent guys.

Fig. 1 shows the values of the horizontal components W_1 and W_2 of wind or hoisting loads, W, in the vertical plane through the guy, for different angles β between the guys and different angles α between the direction of the load and the vertical plane through the guy.

From the curves it can be seen that the condition for maximum tension in the guys as indicated by the heavy line occurs as follows:

For angles $\beta = 0$ deg. to 90 deg. and $\alpha = 0$ deg. the maximum load coefficient equals 1.

For angles $\beta = 90$ deg. to 180 deg. and $\beta - \alpha = 90$ deg. the maximum load coefficient equals $\frac{1}{\sin \beta}$, ranging from unity to infinity.

The following example is typical of a three-guy installation on a stack, but where obstructions occur which necessitate different values of β, say 150 deg., and 120 deg. and 90 deg., the maximum value of β must be used.

Example (Fig. 2): Stack diameter 6 ft.; stack height 80 ft. $= H$; guy collar 60 ft. high $= h$; three guys spaced 120 deg. and at 50 deg. with the vertical. Assume using $\frac{5}{8}$-in. galvanized nineteen-wire strand cable with initial tension in guy ropes of 5,000 lb. per sq.in. Wind pressure 20 lb. per sq.ft. of projected area of stack.

Taking moments about the base, the wind load reaction

W at the collar $= P \times H \div 2h$

where $P = 20 \times 6 \times 80 = 9{,}600$ lb.

$$W = \frac{9{,}600 \times 80}{2 \times 60} = 6{,}400 \text{ lb.}$$

$R = P - W$.

The load coefficient from Fig. 1 for $\beta = 120$ deg. for maximum conditions $= \frac{1}{\sin 120 \text{ deg.}} = 1.155$.

Therefore the horizontal wind reaction $W_1 = 6{,}400 \times 1.155 = 7{,}400$ lb.

Resolving along guy and down stack,

stress in guy $= \frac{W_1}{\sin 50 \text{ deg.}} = \frac{7{,}400}{0.766} = 9{,}660$ lb.

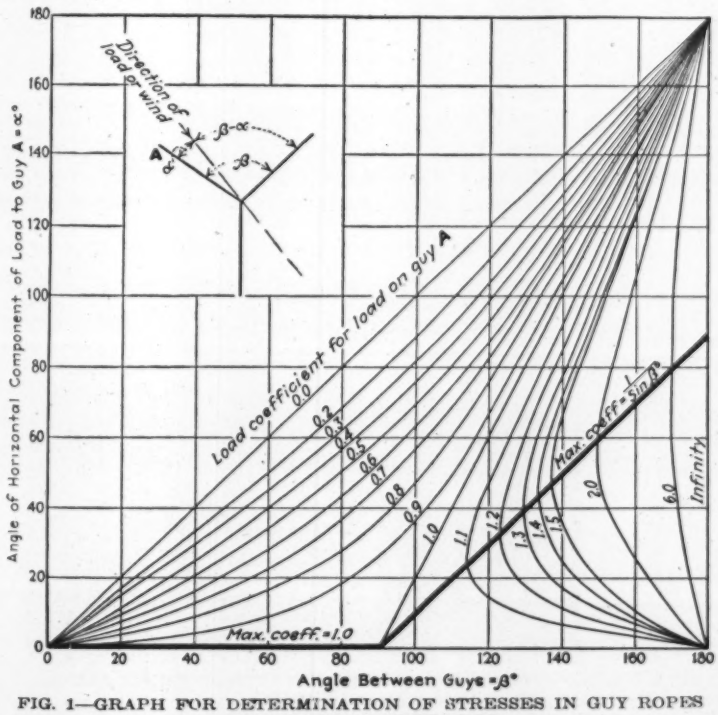


FIG. 1—GRAPH FOR DETERMINATION OF STRESSES IN GUY ROPES AND DERRICK STIFF-LEGS

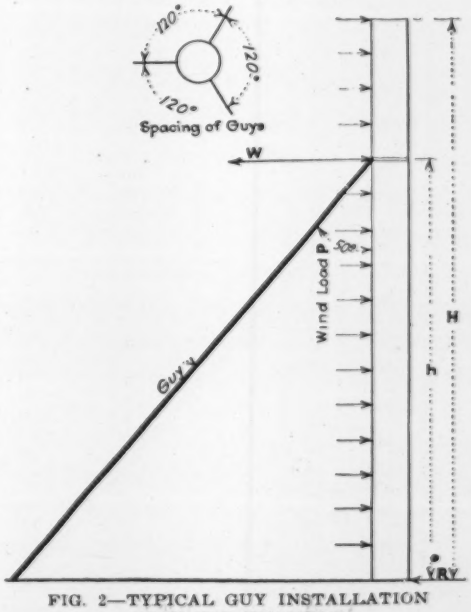


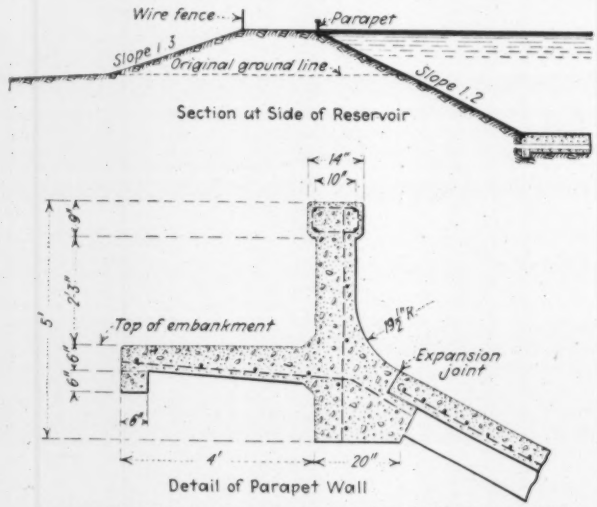
FIG. 2—TYPICAL GUY INSTALLATION USED FOR EXAMPLE

Total stress in guy = 9,660 + initial tension ($\frac{5}{8}$-in. cable) load = 9,660 + (0.307 × 5,000) = 11,195 lb.

Checking from the manufacturers' table of cable strengths the assumed cable is found safe for this load.

Reservoir Parapet Serves Useful Purpose and Adds Finish

A RESERVOIR with 25-m.g. capacity recently built in the northern part of the city of Tacoma, Wash., was formed partly by excavation, using the excavated material to build an embankment, the entire interior then being lined with concrete. The use of a 3-ft. coping



PARAPET WALL SURMOUNTING RESERVOIR LINING AT TACOMA

around the reservoir served in effect to increase the capacity, because it made it possible to retain storage up to an elevation level with the top of the embankment. At the same time that the coping prevents waves from overlapping the fill it also keeps dust and other wind-blown material out of the reservoir and provides a neat and finished appearance to the structure as a whole.

The parapet, the details of which are shown in the accompanying illustration, which, with the information herein, was furnished by W. A. Kunigk, superintendent water division, department of public utilities, Tacoma, Wash., is built on the inner edge of the embankment, which is 14 ft. wide on top. The embankment slope is 1:3 on the outer side and 1:2 on the inside. A fence inclosing the reservoir as a whole is on the outer edge of the embankment crest.

Metal Tongue-and-Groove Joint Eliminated in Wide Pavements

By George H. Baker

General Superintendent, Day Labor Construction, Illinois Division of Highways, Springfield, Ill.

ILLINOIS concrete pavement design requires a longitudinal tongue-and-groove joint in the center of all pavements for two lanes of traffic. A similar joint is required between lanes on the wider pavements. Where pavement is built full width in one operation, it is necessary to form the joint by means of a No. 18 metal parting strip deformed to the proper cross-section. Although this metal strip has no function other than to form the joint, it is necessary to leave it in place.

It has been found more practicable to build a four-lane (40-ft.) road in two 20-ft. operations. On one of the Illinois day-labor jobs it was decided to form this joint between the two 20-ft. slabs by another method and save the cost of the center metal. A piece of oak of trapezoidal cross-section corresponding to the required deformation was bolted to one half of the steel forms used. These forms were then used on the first run of 20-ft. pavement on the side which was to be the center of the 40-ft. pavement. As the second half was laid the concrete was poured against the first half, forming a tongue-and-groove joint. The total cost of the oak strip bolted to the forms was less than $200. There was a saving of the cost of 40,000 ft. of center joint at approximately 9c. per foot plus the labor of setting the joints. The total saving amounted to approximately 2c. per square yard, or $3,600.

Burning Stumps by Vacuum Cleaner Draft Cheapens Land Clearing

BURNING stumps with drafts supplied by an ordinary vacuum cleaner is successful in preparing logged-off lands in Washington for cultivation, according to E. A. Batwell, of the Puget Sound Power & Light Company. The method can be easily used wherever electric power is available and the results are obtained at a comparatively low cost.

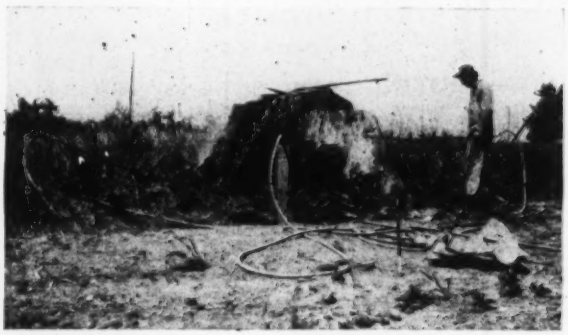


FIG. 1—BURNING STUMPS WITH VACUUM CLEANER DRAFT
Illustration shows cleaner blowing six fires in one stump simultaneously.

The dustbag of the vacuum cleaner is replaced by a

FIG. 2—REMAINS OF STUMP AFTER TWENTY HOURS' BURNING
Hourly attendance and less than 50 cents worth of power destroyed stump and roots.

manifold supplying eight pieces of rubber hose, each terminating in a section of iron pipe. Fires are started with charcoal in holes drilled in the stump at ground level. The air lines, acting as blowpipes, are applied to the fires and are moved inward as burning progresses. The fires, meeting at the center, produce ventilation which consumes the portion of the stump above ground, after which the same firing process is followed, burning out roots below plowing depth. Even rotted roots may be completely destroyed by this method. This process eliminates all digging, blasting and pulling and also reduces the amount of re-leveling required afterward.

The cost of assembling the outfit runs from $20 to $30 and the cost of operation varies with the size and condition of the stump. In one instance a 6-ft. diameter stump burned in nine hours, the roots requiring an additional two hours. An estimated average power cost for eleven large stumps was about 25 cents each. The amount of time required for operation consisted of an hourly visit to advance the pipes.

Letters to the Editor

City Concrete Paving Practice

Sir—The editorial entitled "Where City Practice Lags," in *Engineering News-Record* of Nov. 29, 1928, is certainly a severe indictment of city practice in concrete paving. We realize that our practice in Evanston is not above criticism, but it is so far above the average condition mentioned in your editorial that we feel impelled to offer some comment. We are striving to keep abreast of the rapid advancement in pavement practice by a constant revision of our specifications and inspection methods. Inspection of the concrete pavements constructed in Evanston during the past few years shows that our time and effort are being well spent.

Our specifications for measuring aggregates require that all materials, including water, shall be measured by accurate automatic measuring devices, and no other means of measuring is permitted. Until quite recently weighing batchers were rather elaborate, requiring a permanent set-up which, with our average small letting, would have worked to our disadvantage. We are contemplating changing to this method of proportioning. We limit the amount of mixing water, including moisture in aggregates, to 5 gal. per sack of cement; a water-measuring tank is required on the mixer having an adjustable visible gage and so constructed that the amount of water for each batch shall be separately and accurately measured. A true water-cement ratio specification is a practical impossibility under the local improvement laws of Illinois.

Concrete must be mixed for at least one minute after all materials, including water, are placed in the drum and before any part is discharged therefrom. The mixer must be provided with a batch timer which automatically locks the batch-discharging device during the full mixing period.

It is our practice to divide any street pavement 18 ft. or over in width by a longitudinal joint. We attempt to have the minimum width of slabs between joints 9 ft. However, this is no hard and fast rule, as we attempt to make longitudinal joints and traffic lines coincident. Corrugated metal plates are required to form the longitudinal joints, and we state size and shape of corrugation, also a method of installing and holding them vertical and to grade and alignment during construction. Tie-bars are required across these joints, the area and length of which are governed by the width and thickness of adjoining slabs. "Part at a time" construction is required under our specifications.

Transverse joints, filled with ½-in. thickness of expansion material, are placed at curb lines produced of intersecting streets and at 30-ft. intervals between them. Slip dowels are required across transverse joints.

The use of reinforcing steel in Evanston pavements depends upon character of subgrade and is not a standard requirement. The sectional area of reinforcement when used is governed by dimensions of slab and character of subgrade. Standard specifications call for a slab 8 in. thick, composed of 1:2:3 concrete. Strict attention to preparation of the subgrade and elimination of haul over it after preparation, together with careful finishing operations, have given us pavements in which cracking is to a large extent eliminated.

We use an integral curb. This, together with varying widths of streets, is our reason for not specifying machine finishing. Finishing specifications require rolling with a wire-mesh roller, tamping and floating with a longitudinal float board, removal of laitance, checking with a 10-ft. notched straight-edge, correction of any surface variation, one application of a canvas belt, rechecking with straight-edge, correction of any variations and a final belting operation. This gives us a surface free from transverse waves, water pockets and irregularities. Cores taken from pavements show a density equal to that obtained with a finishing machine.

The storing of aggregates upon the subgrade or upon the immediately adjacent parkways is prohibited. We require the use of a subgrade templet or a method of teeing which will assure us of the result desired. Specifications require that the subgrade be brought to a true shape and also that it be prepared and saturated with water the day prior to the placing of the concrete, and that it be maintained in this condition until the pavement is placed upon it.

We cure with wet burlap and calcium chloride. Other methods of curing may be superior to this, but the mess attendant upon the ponding and moist earth or straw method, the susceptibility of the sprinkling method to be used continually only when closely watched, together with the additional cost of these methods, caused us to adopt the present procedure. Two cores have been drilled from each block of all pavements constructed in Evanston during the past two years, and these have been tested for density and compressive strength. The average 28-day compressive strength for street pavements constructed in 1927 was 4,113 lb. per sq.in. and for 1928 was 4,635 lb.

Evanston pavements are designed and constructed under the supervision of Arthur W. Handford, commissioner of public works and city engineer. He and Charles H. Bartlett, mayor, and Robert M. Brown, commissioner of streets, constitute the Board of Local Improvements.

Evanston, Ill.,
Feb. 11, 1929.

J. W. CLEVELAND,
Assistant City Engineer.

This Material—Concrete

Sir—I am particularly interested in the articles by Nathan C. Johnson on "This Material—Concrete," especially as an attempt to improve the relations between engineer and contractor. His proposed loose specification—and it certainly is loose when it contains the word "comfortably" in clause 3, "Use as much stone as the mix will comfortably carry"—seems to me to be entirely too indefinite, although in form it is based on the right principle of practicable requirements and limitations.

I would propose two definite provisions in the contract: (1) a bonus to the contractor for the production of first-class concrete in accordance with practical specifications, together with financial penalty for poor quality and bad workmanship; and (2) authority to prevent the use of any batch of concrete coming from the mixer which in the judgment of the engineer inspector is not of such consistency and quality as will produce such first-class concrete when it is deposited in the forms and takes its set within those critical four to six hours after water has been added to cement.

Such provisions should lead to two desirable results: The contractor and his men would be stimulated to produce the best, and the engineer would have to find a method accurately to judge the quality of wet concrete poured into forms on the job. Strength tests of set concrete are not sufficient, because strength is not primary, but durability and quality are. Any engineer who so lowers his standards of excellence as to wink at or overlook any attempt, for financial gain, at violations of definite requirements in the specifications is damaging both his own profession and the reputation of the contractor.

New York City,
Feb. 16, 1929.

J. P. J. WILLIAMS.

News of the Week

National Drainage Congress Holds 18th Annual Session

The eighteenth annual session of the National Drainage Congress was held at Memphis, Tenn., Feb. 19-21, at which it was voted to change the name of the organization to National Drainage Conservation and Flood Control Congress and to incorporate under the Illinois laws.

Elwood Mead, commissioner of the bureau of reclamation, Department of the Interior, in his address told the members that "nothing since the construction of the Panama Canal has so gripped the national administration as the proposed harnessing of the Colorado River as provided in the Swing-Johnson Boulder dam bill." He spoke of the dam to be constructed in the Black Canyon as the most costly and difficult irrigation enterprise in history.

An illustrated lecture on riverbank protection by J. K. Melton, Chicago research engineer, dealt with the general principles of valley formation and levee building and protection.

During the last day's session there was sharp discussion between proponents and opponents of the Jadwin flood-control plan. Brig. Gen. T. H. Jackson, president of the Mississippi River Commission, and E. E. Blake, Oklahoma representative on the Interstate Commission for Headwater Control of the Arkansas and Red Rivers, engaged in the discussion. General Jackson spoke for the Jadwin plan and retorted to interruptions that the interrogators evidently were not familiar with the plan. While admitting that the levee protection plan was vulnerable, he suggested that it superseded any reservoir control plan from an economical and engineering standpoint.

Election of officers resulted as follows: President, Arthur W. Large, agricultural agent, Chicago, Rock Island & Pacific Railroad, Chicago; first vice-president, W. G. Potter, Illinois Division of Waterways, Chicago; second vice-president, A. S. Stinnett, industrial commissioner, Board of City Development, Amarilla, Tex.; treasurer, E. G. Jaques, manager of sales, American Steel & Wire Company, Kansas City, Mo.; board of directors, E. V. Willard, water and drainage commissioner, St. Paul, Minn.; G. J. Bell, engineer, Eastern lines, Atchison, Topeka & Santa Fé Railroad, Topeka, Kan.; E. E. Blake, engineer, Oklahoma City, Okla.; P. T. Simons, assistant engineer, Missouri Pacific Railroad, St. Louis, Mo.; B. F. Williams, state reclamation engineer, Austin, Tex.

The place for next meeting will be selected later. Little Rock, St. Paul and New Orleans are seeking next year's congress.

Two Large Railway Systems Planned in the Eastern States

Baltimore & Ohio and the Chesapeake & Ohio Ask Permission to Form New Systems

PLANS for two major railway systems east of the Mississippi were made public last week through applications by the Baltimore & Ohio Railroad Company and by the Chesapeake & Ohio Railway Company to the Interstate Commerce Commission for permission to form unified systems, through the consolidation into one system, of railways some of which they now control and others which they wish to control. Both systems are similar to those proposed in the "four-party plan" presented to the Interstate Commerce Commission two or three years ago when plans were being made to form four major railroad systems east of the Mississippi.

Proposed B. & O. System

The Baltimore & Ohio asks that it be given permission to acquire outright control to the Reading Company; the Central Railroad of New Jersey; Lehigh & Hudson River; Western Maryland; Buffalo, Rochester & Pittsburgh; Buffalo & Susquehanna; Detroit, Toledo & Ironton; Chicago, Indianapolis & Louisville; the Wabash, and the Ann Arbor railroads. It also asks that it be allowed to control (jointly with the Pennsylvania, the New York Central and the Chesapeake & Ohio) the Lehigh & New England; the Montour; the Pittsburgh, Chartiers & Youghiogheny; and the Pittsburgh & West Virginia east of the Ohio River. Joint ownership with the Chesapeake & Ohio of the Detroit & Toledo Shore Line also is asked.

The B. & O. further asks to be granted trackage rights over the Pennsylvania from Driftwood Junction to Newbury Junction, Pa., a distance of 80 miles, or from Driftwood Junction to a connection with the New York Central at McElhatten, Pa., 63 miles, and thence over the Central to a connection with the Reading at Newbury Junction, a distance of 18 miles, to form a new through line to Chicago from New York. Trackage rights are asked over the Wheeling & Lake Erie from Canton to West Zanesville, Ohio, 82.5 miles, and from Creston to Toledo, Ohio, including 108 miles of the Wheeling & Lake Erie and 4 miles of the Toledo Belt Line, also trackage rights over the Pere Marquette or over the Detroit & Toledo Shore Line from Toledo to Detroit. The total mileage of the proposed system would be 13,814.

The railroad in its application states that it has not made leases or other contracts for the acquisition of the railroads which it proposes to consolidate, also that it will include in its system those short lines which the Interstate Commerce Commission believes should be included.

Proposed C. & O. System

The proposed system of the Chesapeake & Ohio includes railways already owned or controlled by the Van Sweringens: the Hocking Valley, the Pere Marquette, the Nickel Plate and the Erie. Other lines to be acquired are the Wheeling & Lake Erie; Chicago & Eastern Illinois; Virginian; Delaware, Lackawanna & Western; Bessemer & Lake Erie; Pittsburgh & Shawmut, and the Pittsburgh, Shawmut & Northern. As in the case of the Baltimore & Ohio, the C. & O. asks one-fourth interest in the Delaware & Hudson; Lehigh & New England; Montour; Pittsburgh, Chartiers & Youghiogheny; the Chartiers Southern; Monogahela; Pittsburgh & West Virginia east of the Ohio, and the West Side Belt. A one-third interest with the New York Central and the Baltimore & Ohio in the Pittsburgh & West Virginia west of the Ohio is proposed, and a half interest with the Baltimore & Ohio in the Detroit & Toledo Shore Line. Trackage rights at a number of points are also included in the application.

In neither case is a definite plan for acquiring the properties presented to the commission for its approval, but instead the commission is asked to give its views as to the way in which control is to be obtained.

Williar Now Chief Engineer of Maryland Roads Commission

Harry D. Williar, Jr., assistant chief engineer of the Maryland State Roads Commission, has been appointed chief engineer of that body. He succeeds John N. Mackall, who resigned on Jan. 10. Mr. Mackall also was chairman of the commission.

Mr. Williar has been associated with the Maryland State Roads Commission for about thirteen years, during which time he filled various positions. He was born in Baltimore in 1885 and after attending the public schools was graduated from the University of Maryland. He was construction inspector for the state roads commission from 1908 until 1910 and then served until 1912 as maintenance inspector. In that year he became assistant engineer for the Baltimore Paving Commission and remained in that position until the war. During the war he saw service on the western front and in Germany.

Rocky Mt. Section A.W.W.A. Holds Its Largest Meeting

The third annual meeting of the Rocky Mountain Section, A.W.W.A., held at Denver Feb. 14 and 15, had a larger attendance than either of the two previous meetings, 25 members and 55 guests being registered. Seven formal papers on various water-works and related subjects were read and four lantern slide and motion picture talks were given, the latter chiefly by representatives of equipment concerns. There were also round-table discussions on mechanical vs. slow sand filters, prechlorination and other topics and demonstrations of coagulation, filtration and of zeolite softening.

The principal officers elected were: chairman, P. R. Revis, city engineer, Cheyenne, Wyo.; secretary-treasurer, Dana E. Kepner, state sanitary engineer, Denver, Colo.

At the request of the Water-Works Manufacturers Association there were no exhibits at this convention.

Engineering and legal problems in connection with water rights were discussed in papers by George M. Bull, consulting engineer, and Malcolm Lindsay, attorney, Denver Water Board. Mr. Revis read a paper on distribution systems and service pipes. R. E. McDonnell, Kansas City, Mo., presented a paper on water softening and also a lantern slide talk on the St. Francis dam failure. Other illustrated talks were by representatives of the Dorr Company, the National Tube Company and the Wilson Machinery Company, the latter on trenching machines.

Code of Selling Practices for Structural Steel

A committee to draft a code of standard selling practices for the structural steel industry has been announced by Charles N. Fitts, president, American Institute of Steel Construction. The committee, whose membership follows, will prepare a draft of a code and submit it to the institute for formal adoption: Robert T. Brooks, chairman, the George A. Just Company, Long Island City, N. Y.; T. J. Foster, National Bridge Works, New York City; A. M. Conneen, Jr., Hedden Iron Construction Company, Hillside, N. J.; H. E. Detwiler, Anthracite Bridge Company, Scranton, Pa.; and R. L. Kift, Lehigh Structural Steel Company, Allentown, Pa. Regional contact committeemen have also been appointed to co-operate with the committee as an assurance that the work is in keeping will all local requirements and conditions.

In commenting on the program, Charles F. Abbott, executive director of the institute, said: "Police power is not available to enforce the provisions of any code. Its usefulness must depend upon individual initiative. In proclaiming a code of standard selling practice, the institute will establish principles that should guide selling activities. The moral effect will tend to elevate the sales methods to a higher plane. By constantly featuring the code adopted by the institute the industry will do much toward insuring better selling practices."

Quick Turnover of $2,000,000 Providence Bond Issue

A quick turnover in the municipal bond field occurred on Feb. 20, when bankers bought $2,000,000 city of Providence (R. I.) bonds at 2 p.m. and reported distribution of more than two-thirds of the issue by the end of the financial day. The offering consisted of $1,000,000 twenty-year sewer and bridge obligations and $1,000,000 30-year school bonds, all 4¼ per cent. It was taken by the National City Company, the Bankers Company of New York, the Old Colony Corporation and the Industrial Trust Company of Providence. The price was 99.309 and the bonds were marketed at 100¼. The yield on the 20- and the 30-year obligations is 4.21 and 4.22 per cent respectively.

Port Jervis Votes to Buy Property of Local Water Company

By a vote of 547 for to one of 24 against, the electors of Port Jervis, N. Y., voted on Feb. 20 a bond issue of $600,000 for the purpose of acquiring the property of the Port Jervis Water Works Company. The purchase price is $590,000. It is expected that possession of the plant will be taken on April 1. Christoph Graebner is secretary of the company.

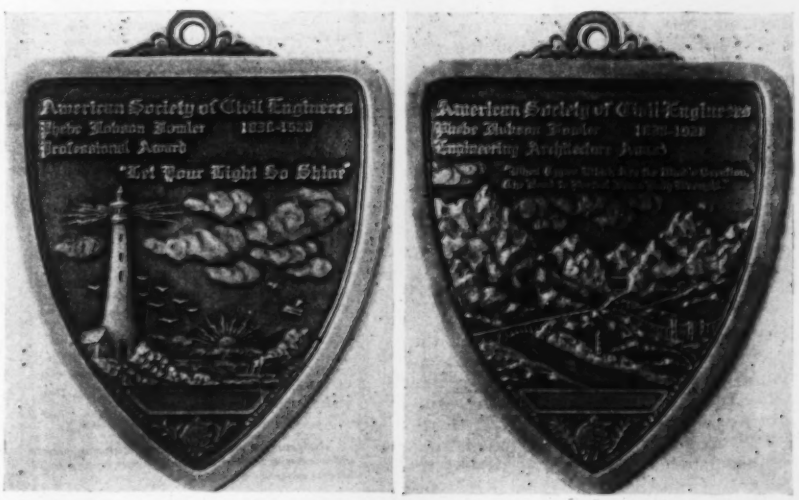
Buffalo Engages Engineer to Make Sewage-Disposal Plan

A comprehensive plan of sewage disposal for Buffalo, N. Y., in contemplation for years past, is to be undertaken at once. It will include trunk and intercepting sewers and sewage treatment. First attention will be given to the South Buffalo section of the city, in the hope of getting construction started this year. Planning work will be directed by George B. Gascoigne, consulting engineer, Cleveland, Ohio, in immediate charge of Frank C. Tolles, who is associated with Mr. Gascoigne. Some years ago Mr. Tolles was district engineer at Buffalo on the sewage-disposal studies made for the International Joint Commission. He will give his entire time to the Buffalo work in conjunction with the staff attached to the office of Carl L. Howell, assistant city engineer. George F. Fisk is commissioner of public works of Buffalo.

Co-operative Construction Course Offered by Mechanics Institute

The Mechanics Institute, of Rochester, N. Y., will offer next fall the first co-operative course in construction, supervision and architectural drafting established by an educational institution in this country, according to President John A. Randell. It will be a three-year course to train young men for the architectural and building construction fields. Architects and builders are aiding the plan and will provide summer employment for the students, to give them practical experience following the class-room work during the winter.

TWO NEW AWARDS TO BE PRESENTED BY AMERICAN SOCIETY OF CIVIL ENGINEERS



Two new awards to be known as the Phebe Hobson Fowler Engineering Architecture Award and the Phebe Hobson Fowler Professional Award are now available by the American Society of Civil Engineers. Charles Evan Fowler, a member of the society, has donated securities totaling $10,000, the income from which will be used to pay the annual costs of appropriate medallions and certificates. The awards are illustrated above, the Professional award on the left and the Engineering Architecture award on the right.

Scavengers at San Francisco Form City Sanitation Guild

The City Sanitation Guild has been formed by the scavengers of San Francisco to apprise the city's householders of the service being rendered by the scavengers and the status of the garbage collection and disposal system. One of the recent publicity efforts of the guild is reproduced herewith. Standing back of the guild are three organizations—namely, the Scavengers' Protective Association and the Sunset Scavengers' Association (which are affiliated organizations for the collection of garbage from the two parts into which they have divided the city) and the Scavengers' Protective Union, which represents the two associations for the purpose of operating the incinerator where the garbage and refuse are destroyed.

The associations operate on a plan whereby the collections from each route are turned into a common fund for equable distribution among the operators, so that returns from the more profitable routes help increase the income from less remunerative areas. There are about 400 collectors who are stockholders in this organization and share directly in the profits. In addition, 100 or more others are employed by the stockholders on a wage basis to fill out their ranks to the strength necessary to collect over the entire city.

Under the garbage collection ordinance that has been in effect in San Francisco since 1927, it is mandatory for the Board of Health to issue a permit for garbage and refuse collection to any firm or individual whose application is accompanied by a petition signed by 20 per cent or more of the householders or firms on the routes to be served. This plan has the disadvantage that it restricts Health Department control and encourages pirating of routes.

An injunction suit to estop the city from continuing operation of the old Thackeray destructor where the refuse is now burned is still pending. No action is in immediate prospect for relieving the situation in that respect, although the scavengers' organization claims it can finance the construction of a new incinerator when the right terms and conditions are worked out.

Mulholland Retained by City of Los Angeles

William Mulholland, builder of the Los Angeles aqueduct, whose resignation after more than 50 years of service with the city was announced in *Engineering News-Record*, Nov. 22, 1928, p. 785, will be retained as a consulting engineer under a resolution passed by the City Council on Feb. 18. His retainer in this capacity was approved, it is reported, because the Council desires to have his advice and assistance in the planning and building of the Colorado River aqueduct. It is expected that Mr. Mulholland will retain an office at the headquarters of the Bureau of Water Works and Supply.

THIS IS TODAY'S MOST IMPORTANT NEWS TO THE HOUSEHOLDER

We Have Cleaned Our Own House

Now help us keep clean, scientific and economical the City's garbage collection system

WHEN we of the City Sanitation Guild, of which the Scavengers' Protective Union is a part, gave you our first message a month ago, through the public press, we told you that we were going to clean out all that was not wholesome in garbage collection in San Francisco.

We have kept our promise!

We have rid ourselves of the Cavagnaro regime and everything it represents, and are now operating non-politically, with the single motive of giving service to the people for a fair return on our labor.

The City Sanitation Guild is composed of 500 trained and faithful Scavengers, whose families for two generations have guarded the City's health.

These men are now no longer under the yoke of the Cavagnaro administration, which ensnared them in a maelstrom of politics. We have now taken politics out of the garbage collection system and made it what it should be—A PUBLIC SERVICE.

It is noteworthy that even during the period when the Cavagnaro influence harassed our good men of the Sanitation Guild from within and without, they never permitted the public to suffer, and the garbage can was always removed at the appointed time.

But we have now cleaned our own house and will serve you more efficiently in peace and harmony.

We ask you to bear with us until a logical and scientific garbage rate schedule can be provided, and until that time to continue paying your present rate.

(This message is issued for the purpose of creating mutual understanding of San Francisco's health problem—your garbage collector contributed toward its cost.)

City Sanitation Guild

Scavenger's Protective Union

SAN FRANCISCO SCAVENGERS APPEAL FOR PUBLIC SUPPORT

The advertisement, which appeared in the local press, hints of internal dissension or outside competition.

Brief News

BUILDERS AND ARCHITECTS in Indianapolis are planning the construction of a new ten-story architects' and builders' building at Pennsylvania and Vermont Sts. The structure will house nine organizations of engineers, contractors and architects.

EXTENSIVE EXPANSION of the Erie Railroad yards in Hornell, N. Y., will be made during 1929, it is announced. Work will begin about April 1 and approximately $400,000 will be spent this year. The first work will be the enlargement of the fast freight yards east of the East Ave. crossing.

CONSTRUCTION OF MARINE RAILWAYS over several rapids on the present water route to the Red Lake and Woman Lake mining fields in the Patricia district of northern Ontario is to be undertaken this year at a cost of $50,000. The work will be shared jointly by the Ontario government and mining and transportation interests.

THE MERGER OF THE THREE Seattle construction firms of McEachern Construction Company, the J. A. McEachern Company and the General Construction Company has been announced. Officers of the new firm are: president, J. A. McEachern; vice-presidents, D. V. McEachern and J. W. Lawlor, who will also act as general manager; secretary, J. Samuelson.

AN ADDITIONAL $275,000 for improvements on the Houston (Tex.) ship channel is announced in Washington. This makes a total of $873,000 available for this purpose during 1929. Tonnage figures for the port of Houston are not yet available for 1928, but they are expected to show a heavy increase over those of 1927, when 12,000,414 tons was handled, more than twice the volume at the port of Galveston.

THERE WERE 1,324 AIRPORTS and landing fields in the United States at the beginning of the year, with 894 more proposed, according to the Department of Commerce. States leading in the number of airports and landing fields are: California, 143; Texas, 101; Pennsylvania, 83; Ohio, 62; and Illinois, 60. In the proposed number the leading states are: Pennsylvania, 65; California and New York, 60; and Texas, 54.

A SPECIAL COMMITTEE of the Highway Research Board, National Research Council, has been formed to conduct an investigation of proper curing methods for concrete pavements. The work will consist largely in correlation of the research work being carried on by the Bureau of Public Roads and the various state highway departments. F. C. Lang, of the University of Minnesota and the Minnesota State Highway Department, will be chairman of the committee.

Contract Let for Bridge Over Suisun Bay, California

The Southern Pacific Railroad on Feb. 26 awarded contracts for concrete piers and steel superstructure of a main line bridge across Suisun Bay between Army Point and Benicia, Calif. The contract for the foundation, including piers with maximum height of 214 ft., went to Siems, Helmers & Schaffner, Inc., St. Paul, Minn., the work to be completed within sixteen months after March 1. The structural steel contract went to the United States Steel Products Company, all steel to be placed within three months after the substructure is finished.

This bridge, which is on the main line east from San Francisco, is to cost about $12,000,000 and will replace the old car ferry now in service. Its length will be 6,000 ft. More detailed information about the project was published in *Engineering News-Record*, Aug. 30, 1928, p. 329.

European Engineers Arrive to Inspect Hydro-Electric Plants

A. V. Winter, chief engineer, and B. E. Vedeneev, assistant chief engineer of the Dnieper electric power plant under construction in the Soviet Union, and six other leading Soviet technicians have arrived in this country to study American hydro-electric development and to participate in negotiations in regard to placing orders for several turbines for the plant, with a capacity of 80,000 hp. each. These turbines will be the largest ever installed in hydro-electric plants.

The Dnieper power station will be equipped with ten such turbines and will attain a capacity of 800,000 hp., making it the largest hydro-electric power plant in Europe. The construction of the Dnieper power plant was started two years ago, 60 miles below the city of Dnepropetrovsk, in the Ukraine. Hugh L. Cooper & Company, of New York, have been engaged as consultants on the project, which will involve a total outlay of $100,000,000.

The Dnieper dam, which will be completed within three years, will raise the level of the water in the Dnieper River 37 meters. This will result in raising the water above the rapids which are located several miles above the site of the dam and will make the Dnieper River navigable in that section. Locks will be built connecting the upper and the lower streams of the Dnieper.

Tunnel Doors Again Used by P.R.R.

The Pennsylvania Railroad has resorted to the use of doors on the Caledonia tunnel on the Low Grande branch in Pennsylvania to prevent the formation of ice within the tunnel. The use of tunnel doors was abandoned 28 years ago, but is to be restored in Caledonia in an effort to cope with the extreme ice conditions within the tunnel.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Duty Is Urged on Cement and Building Brick—Topographic Mapping Expenditures Revealed

A DUTY on cement was urged before the ways and means committee Feb. 20 at the beginning of the free list hearings by a number of American manufacturers complaining of foreign competition along the seaboard. G. S. Brown, speaking for several companies, asked a rate of 23c. per hundredweight to equalize foreign and domestic production costs. It was argued that imports from Belgium have taken business to such an extent that certain plants in the United States operate at a loss.

Importers answered by pointing out that foreign cement fills less than 2 per cent of the national construction needs. Cement is a low-priced commodity and a duty would amount to an embargo, thus violating sound policy, they argued. Attention was called to the large dividends paid by many cement companies.

A combination to fix prices was hinted by L. P. E. Giffroy, who appeared for the National Council of Exporters and Traders.

Requests for duties on building brick, previously discussed under another schedule, were renewed before the committee on grounds of seaboard competition from Belgium, as in the case of cement. The New York market is being entered to the extent of more than 100,000,000 common brick per year, it was shown, a condition not dreamed of when the existing tariff act was drawn. A rate of 50 per cent ad valorem was proposed to protect brick producers in the Hudson Valley, whose production costs do not permit them to meet the low Belgian price.

Topographic Mapping Figures

The relative responsibility of the Department of the Interior and the Bureau of the Budget in reducing estimates for topographic mapping under the Temple act, which was approved Feb. 27, 1925, has been revealed as a result of an investigation being conducted by the mines and mining committee of the Senate. The mining industry makes large use of topographic maps and has been greatly handicapped by the failure to complete the map of the United States. At the direct request of the committee the Geological Survey has furnished the committee the following table showing the estimates and appropriations since the passage of the Temple act:

Fiscal Year	Appropriation Bill	Preliminary	Approved by Department	Approved by Budget	Approved by Congress
1926	Int. Dept.	$675,454	$499,925	$485,000	$485,000
1926	Deficiency	200,000	.....	.....	73,300
1927	Int. Dept.	825,000	445,000	437,000	451,700
1927	Supplemental	375,000	233,500	.....	.....
1928	Int. Dept.	750,000	500,000	515,000	510,200
1928–29	Defficiency	.....	.....	.....	100,000
1929	Int. Dept.	750,000	525,000	505,000	505,000
1929	Welch Act	41,700	41,700	34,000	Not yet passed
1929	2nd Def. State Coop	20,000	20,000	20,000	Not yet passed
1930	Int. Dept.	800,000	700,000	635,000	Not yet passed
1930	Int. Dept. Nat'l Pks.	.....	.....	.....	45,000

Charles Gow Leaves Engineering to Enter Government Service

Charles R. Gow, one of the foremost engineers of Boston, has been made postmaster of that city and will take office on March 1. He expects to give up private practice to devote himself entirely to government work, except possibly to act in an advisory capacity in certain fields of foundation work to which he has given a great deal of attention in the past few years.

Mr. Gow is a graduate of the engineering department of Tufts College, in the class of 1893, and has been active in engineering and contracting work in Boston for the greater part of the time since that date, first as an assistant engineer with the Boston Transit Commission and then as a general contractor on sections of the East Boston tunnel and the Washington St. tunnel in Boston. Subsequently he built the water-filtration plant for the city of Springfield, Mass. In recent years he has specialized in foundation work, having developed a special method of sinking large piles by the use of caissons. During the World War he served as a lieutenant colonel in the Quartermaster Corps in charge of construction work. From 1915 to 1916 Mr. Gow was chairman of the Boston Licensing Board. In the past he has served as president of the Boston Society of Civil Engineers, vice-president of the American Concrete Institute and president of the Associated Industries of Massachusetts and of the Construction Division Association.

In response to another request as to the damage resulting in the flooded areas of the Mississippi Valley because of the absence of topographic maps, the Survey states that "its engineers are confident that substantial savings of property and of human life would have resulted had the relatively high and relatively low areas been delineated on accurate maps and thus have been definitely known before the flood crests arrived."

Wilmington Bridge Bill Shelved

After vigorous protests from the War and Navy departments had been registered at formal hearings on the Wilmington bridge bill, the interstate commerce committee of the House reached an agreement to table the measure.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual convention, Chicago, March 5-7.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Dallas, Tex., April 24-26.

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THE ARKANSAS ENGINEERS' CLUB at its recent meeting in Little Rock elected the following officers: president, L. J. N. Keliher, of Little Rock; vice-president, Fred Hargett, Little Rock; secretary-treasurer, W. Terry Field, Little Rock.

AMERICAN SOCIETY OF CIVIL ENGINEERS, San Francisco Section, met on Feb. 19. Dr. C. A. Kofoid, of the department of zoology, University of California, addressed the section on "Termites in Relation to Building and Other Industrial Uses of Wood."

THE HIGHWAY ENGINEERS' ASSOCIATION OF MISSOURI met in St. Louis on Feb. 12 and heard addresses by Clifford Shoemaker, district engineer of the Bureau of Public Roads, on the use of aero-photography for the elimination of possible errors in highway development and regional planning; D. B. Levi, construction engineer for the Missouri State Highway Department, on the various methods of gravel surfacing of roads, and Roy F. Britton, president of the Automobile Club of Missouri, on the development and maintenance of local roads supplementary to the state highway system.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS, Los Angeles Section, at its meeting of Feb. 13 heard a talk by Manly P. Hall on the primitive modes of transportation as still practiced in many lands. A symposium followed on the general topic of transportation. Franklin D. Howell, general manager Motor Transit Company, discussed motor stages; W. R. Armstrong, general superintendent, Union Pacific System, spoke on steam and electric railroad problems; G. F. Nicholson, Los Angeles harbor engineer, described the latest freight-handling equipment at harbor terminals, and R. C. Diggins, traffic development manager, Maddux Air Lines, reviewed recent development of airplane routes.

THE WESTERN WASHINGTON SECTION of American Society of Civil Engineers at its annual dinner meeting on Feb. 8 indorsed the proposed law for registration of professional engineers in the State of Washington. Similar indorsement was given the measure by the Western Washington Section, A.S.M.E. The bill as now drafted provides for a state board of examiners financed from fees after the first temporary loan for establishing procedure, defines requisite standards for new applicants after those now practicing the profession are registered as required by the Constitution and provides for reciprocal arrangements with states to remove the present disadvantage experienced by Washington engineers doing business in adjoining states or others now requiring registered professional engineers and surveyors in responsible charge of certain work.

THE CONNECTICUT SOCIETY OF CIVIL ENGINEERS at its annual meeting elected John K. Punderford, of New Haven, president of the Connecticut Company, an honorary member and awarded the prize for the best paper in the 1928 *Proceedings* to Charles E. Price for his paper "Payson Park Reservoir, Lined With Gunite." The society now has 760 members. Officers elected for 1929 are: President, E. Irvine Rudd, Glenbrook; first vice-president, Albert L. Donnelly, New Haven; second vice-president, Elmer C. Welden, Hartford; secretary and treasurer, Clarence M. Blair, New Haven; directors, George E. Hamlin, Hartford; H. Jackson Tippet, New Haven; James A. McElroy, Bridgeport; Elwood T. Nettleton, New Haven.

Personal Notes

JOHN A. WHITING has been reappointed state engineer of Wyoming by Governor Emerson.

WILLIAM A. HEMPHILL has been appointed chief engineer of the Airport Development & Construction Company, a company recently organized in Philadelphia to handle every phase of airport development work.

HOWARD S. JUDSON, of Rochester, N. Y., will retire on March 1 after 41 years' service with the city engineering department, and will take up private practice. Mr. Judson entered the city's service in 1888 under Isaac Quimby, city surveyor, and for some years has been senior draftsman.

F. W. GREEN, formerly with the Truscon Steel Company, of Youngstown, Ohio, and the American Bridge Company, of Ambridge, Pa., in the engineering department, is now efficiency engineer and production manager of the Treadwell Construction Company, of Midland, Pa.

WILDER KENAN, who for the past four years has been design engineer for the Austin Bridge Company, of Dallas, Tex., has severed connection with that company and associated himself with Homer M. Matthews to form the firm of Matthews & Kenan, consulting engineers, located in San Antonio, Tex. This firm will engage in bridge and building structural design and special engineering projects.

LEO SHADIC, for the past 8½ years with the Pittsburgh-Des Moines Company in both the Pittsburgh, Pa., and Richmond, Va., offices and on field construction in the Middle Atlantic and Southeastern States, has accepted a position in the plant engineering department of the U. S. Gypsum Company at its New Brighton, N. Y., works. Previously Mr. Shadic had industrial plant experience with the Atlas Portland Cement Company.

NEIL WELDEN, until recently employed as a designer in the bridge department of the Cleveland Terminals Company, has accepted a similar position with the Union Pacific Railroad and will make Omaha, Neb., his headquarters. Mr. Welden was employed by the Terminals company on the design of new bridges necessitated by trackage changes on the railroads entering the new terminal.

ANSON MARSTON, dean of Iowa State College, and Prof. ARTHUR N. TALBOT, of the University of Illinois, were elected to honorary membership in the American Concrete Pipe Association at its twenty-second annual convention held in Detroit Feb. 14-16. Dean Marston is chairman of the joint concrete culvert pipe committee and has done considerable research work on trench loads and loading of concrete pipe and Professor Talbot was responsible for important early research in reinforced-concrete culvert pipe.

Obituary

WILLIS HATTERSLEY, 75 years old, one of the most prominent general contractors in northern Indiana, died recently at his home in Fort Wayne. He succeeded his father in the contracting firm of A. Hattersley & Sons, established in 1856, perhaps the oldest contracting company in the state.

Cost and Contracts

E. N.-R. Index Numbers

Cost			Volume		
Feb. 1, 1929		**210.40**	**January, 1929**		**325**
Jan. 1, 1929		209.40	December, 1928		244
Feb. 1, 1928		204.65	January, 1928		208
Average, 1928		206.78	Average, 1928		287
Average, 1927		206.24	Average, 1927		263
1913		100.00	1913		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Feb. 26, with some comparisons, total as follows:

(In Thousands of Dollars)

	Feb. 26, 1929	Feb. 18, 1929	Feb. 28, 1928
Building:			
Industrial	$5,168	$5,354	$3,237
Commercial	59,011	48,074	72,505
Streets and roads	4,498	2,346	9,711
Other eng. constr.	25,048	10,417	.....
Total	$93,725	$66,191	$85,453
Total, all classes, Jan. 1 to Feb. 26:			
1929			$793,005
1928			515,790

Construction Equipment and Materials

January Cement Shipment 12.6 Per Cent Under Year Ago

The ratio of operation to capacity of the cement industry in January was 46.5 per cent, according to the Bureau of Mines. Production amounted to 9,781,000 bbl., shipments were 5,735,000, stocks on hand at end of month were 6,696,000. Compared with January, 1928, production was 0.1 per cent more, shipments 12.3 per cent less and mill stocks 6.3 per cent higher.

Business Notes

WELLMAN - SEAVER - MORGAN COMPANY, Cleveland, Ohio, announces that it has appointed Lawrence N. B. Bullock, Edificio Oliver, 16 de Septiembre No. 5, Mexico, D. F., as its sole representative in Mexico for the sale of its equipment.

CUTLER-HAMMER, INC., Milwaukee, Wis., announces the purchase of Trumbull Vanderpoel Electric Manufacturing Company, of Bantam, Conn., which will be operated as a subsidiary under its present name. The purchase will add a complete line of meter service and safety switches to the present Cutler-Hammer line of motor control, wiring devices and allied electrical items.

BARBER-GREENE COMPANY, Aurora, Ill., has recently opened a new office in Cedar Rapids, Iowa, to be under the supervision of Jack Marson, who has been with the company for a number of years. W. E. Toole opened at the same time a branch office under Mr. Marson at 1106 Nicholas St., Omaha, Neb.

MCEVERLAST, INC., manufacturer of protective coatings and owner of the Hunt process of curing concrete, announces the establishment of a Chicago office at 35 East Wacker Drive in charge of Lee S. Trainor, formerly of the Portland Cement Association.

MILWAUKEE CORRUGATING COMPANY, Milwaukee, Wis., announces that an addition is being made to its Eastern plant, the Eller Manufacturing Company, Canton, Ohio, involving about 50,000 sq.ft. of floor space.

H. O. PENN MACHINERY COMPANY, INC., New York City, announces that M. B. Rider, formerly New York sales manager for the T. L. Smith Company, has joined its organization as manager of the roadbuilding department.

B. W. DRUCKENMILLER, for the past sixteen years associated with the Crescent Portland Cement Company, of Wampum, Pa., is now connected with the Penn-Dixie Cement Corporation, New York City, assigned to special sales work.

SULLIVAN MACHINERY COMPANY, Chicago, has recently appointed McCarthy, Jones & Allen, Inc., 111 First Ave., South, as its distributor for portable and stationary air compressors in Nashville, Tenn.

MURRAY IRON WORKS COMPANY, Burlington, Iowa, announces the appointment of the C. B. Davis Engineering Company, Brown-Marx Building, Birmingham, Ala., and Flickinger, Meyers & Rudolph, 129 West Second St., Los Angeles, Calif., as its district turbine sales representatives.

URQUHART SERVICE, 509 Seventeenth St., Denver, Colo., has been appointed exclusive intermountain representative for the Dot Lubricating Equipment Company.

EDWARD LUPTON, president of David Lupton & Sons, manufacturers of steel products, died at his home in Jenkintown, Pa., on Feb. 21. He was 63 years old. Mr. Lupton was a past-president of the Builders Exchange of Philadelphia and was third vice-president of the Ornamental Iron and Bronze Association of America.

New Developments

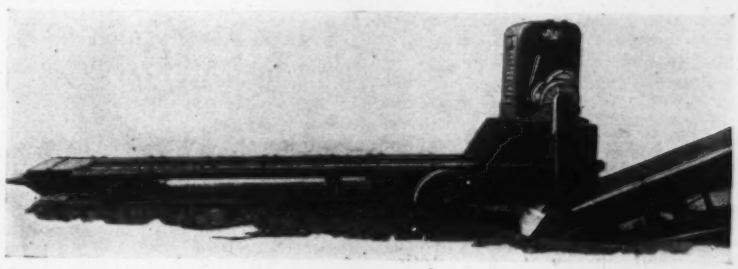
Portable Belt Unloader for Hopper-Bottom Cars

For unloading cars of all bulk material, the Barber-Greene Company, Aurora, Ill., announces a new belt feeder. It will handle such materials as sand, gravel, slag, crushed stone, coke, hard coal, cinders, iron oxide, fine ore, molding sand and any other free-flowing material usually transported in hopper-bottom cars.

The machine eliminates the necessity for constructing a large pit under the railroad tracks, always an expensive and troublesome procedure. A small pit on the outside of the railroad track to permit the conveyor hopper to sit under the discharge end of the gravel feeder is all that is needed.

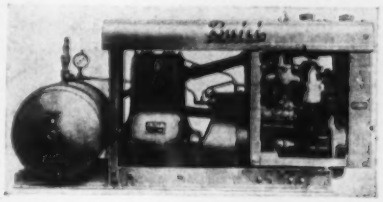
It is claimed that the feeder will speed up unloading, will control the flow of the material within the capacity of the conveyor and will protect the conveyor and especially the belt from overloading and damage. It is said to be possible to unload an entire car of free-flowing material without shoveling.

The machine may be used either over the rail or under the rail as required. The maximum thickness through the feeder frame, including the top sliding plate, is 4⅛ in. Either an electric motor or gasoline engine can be used to drive the feeder. The machine gasoline driven weighs 1,690 lb. and electrically driven 1,520 lb.

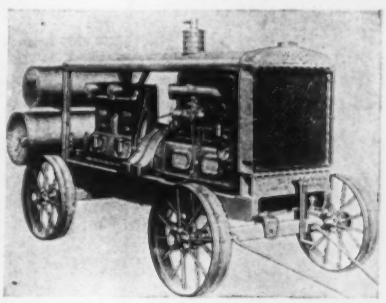


Interchangeable Parts Feature New Line of Compressors

A new line of air compressors offering the user an unusually wide selection in sizes and styles is being produced by the Buhl Company, Old Colony Building, Chicago. The line is available in



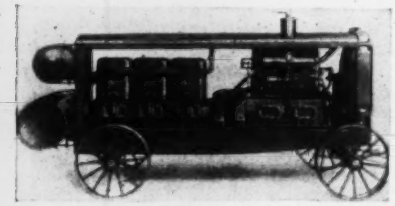
30, 55, 90, 100, 110, 220 and 330 cu.ft. displacements. Various style mountings are available. One of the most unusual and important features is that all parts, except the crankshaft unit, are inter-



changeable on all sizes and types of compressors.

Lubrication is obtained by a pump force-feed system. All bearings are bronze backed and babbitt lined. A bell housing connection between the engine and compressor is claimed to give

all the advantages of a single unit without any of its disadvantages. The accompanying illustrations show in order the 30, 220 and 330 size units. An in-



strument board groups all instruments in one easily accessible and safe place. The small unit illustrated is useful for operating paint-spraying equipment, carving tools, small air-operated wire brushes, for inflating truck tires on construction jobs and for similar work. The 220-ft. machine will operate three rotating rock drills, or five pavement breakers, or seven clay spades, or six riveting hammers, or eight chipping hammers, or twelve tie tampers. The 330-ft. machine is suitable for operating four rotating rock drills, or six pavement breakers, or ten clay spades, or ten riveting hammers, or twelve chipping hammers.

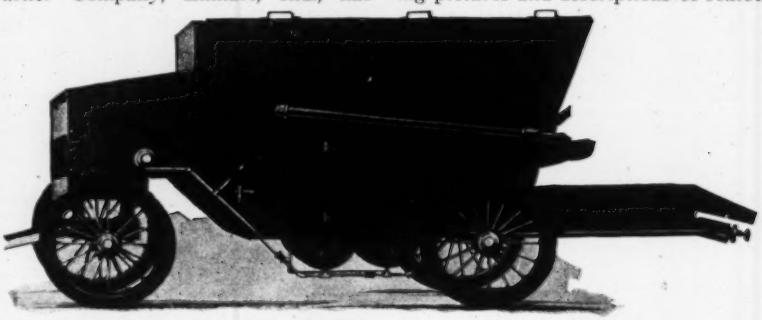
A 10-Ton Motor Roller With Single Lever Control

A new 10-ton motor roller has recently been announced by the Ames Iron Works, a division of the Pierce, Butler & Pierce Manufacturing Corporation, Oswego, N. Y. The roller is powered by a 60-hp. Hercules six-cylinder engine and has three speeds forward and three reverse. A feature of

the machine is single lever control covering both forward and reverse motions. Another important feature is that the front roll pivots on the center line of the axle so that uneven road surfaces cause no swaying of the front end of the roller, making steering easy and positive. This feature is also claimed to prevent setting the roll on edge when making short turns. A built-in differential materially aids in this respect, also, since it permits freedom of side movement of the front end of the roller. An air-operated scarifier is available with the machine. All moving or wearing parts are entirely inclosed, and the heavier operating parts are so mounted as to secure a low center of gravity. The roller has a wheelbase of 120 in., an over-all width of 78 in. and a height of 70 in. The length, including the scarifier, is 209 in. The rear rolls are constructed similar to the front rolls (semi-steel casting with rolled wrought iron spikes) except that each roll is a single section 60 in. in diameter and 20 in. wide, while the front roll is made in two sections 36 in. in diameter with a total width of 44 in.

New Asphalt Street Repair Unit for Small Cities

For those cities which cannot afford expensive mechanically operated asphalt repair machinery, the Chausse Oil Burner Company, Elkhart, Ind., has



developed a new model known as Model H-1. It is a portable hand mixing plant and as shown in the accompanying illustration is self-contained, mounted on steel wheels with roller bearings and 32x5-in. solid rubber tires. It has a towing tongue for ready attachment to a motor truck or tractor. At the front is a tool-heating compartment equipped with a Chausse oil burner. In the next section is located a tar kettle with a capacity of 150 gal. An oil burner heater is claimed to melt the entire capacity in about 45 minutes. The tar is conveyed through a 2-in. pipe to a measuring trough at the rear. Under the tar kettle is a large compartment for tools and accessories, including a hand-pressure pump for the fuel tanks. Three storage bins are placed at the rear of the machine, one for stone, one for sand and one for stone dust or chips. These bins discharge upon a large drying and mixing pan.

New Publications

Airplane Hangar Construction—National Lumber Manufacturers Association, Washington, D. C., has issued a revised and larger booklet on airplane hangar construction for distribution among civic committees and members of city and town councils and chambers of commerce where construction of airports is being considered or ports already exist and improvements are being contemplated. The booklet includes a general discussion of airport requirements, the federal regulations governing aircraft work, experiences of many communities in selecting sites, laying out fields and runways, financing, erecting buildings, providing paved areas and making available local transportation. Another section of the booklet includes eight plates of plans and elevations for several standard-size hangars. A table is included giving span, length and height over all of 105 recognized commercial airplane models.

Motor Trucks—Autocar Company, Ardmore, Pa., announces the publication of a new 40-page booklet containing pictures and descriptions of Autocar trucks at work, devoting several pages to a review of the developments by leading manufacturers supplying the highway and contracting fields with shovels, ditchers, mixers, conveyors, etc.

Bituminous Coatings—Benjamin Foster Company, Philadelphia, Pa., has published a 38-page catalog describing its complete line of protective coatings and mastics known as Foster I.B.M. (Impregnated Bituminous Materials) Bituminous Coatings. Designed essentially as anti-corrosive materials to be applied to iron and steel surfaces not easily accessible and subject to corrosion, they are also available in slightly altered form for use on concrete as a protective and waterproofing membrane, and in road work as filler and expansion joint material. The catalog describes these and other uses.

Road Machinery—J. D. Adams Company, Indianapolis, Ind., announces its 1929 catalog of 56 pages setting forth data on its adjustable leaning wheel graders, elevating graders, dump wagons and other road machinery. The company's new 12- or 14-ft. blade grader is given considerable space, as are also the 6½-, 7-, 8-, 10-, 12- and 14-ft. leaning wheel graders. Many illustrations are included both of machine details and of construction operations upon which the company's equipment is shown in use.

Manufacturers and Trade Associations

CALENDAR

Annual Meetings

NATIONAL RAILWAY APPLIANCES ASSOCIATION, INC., Chicago; 21st annual exhibition, Coliseum, Chicago, March 4-7.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; annual convention, Asheville, N. C., April 15-17.